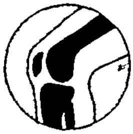
THE URINARY TRACT

A Handbook of Roentgen Diagnosis

THE HANDBOOKS OF
ROENTGEN DIAGNOSIS



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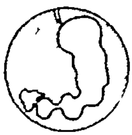

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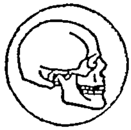

THE SKULL, SINUSES & MASTOIDS KARL KORNBLUM, M.D *
**Deceased, successor to be announced*

THE URINARY TRACT: H DABNEY KERR, M.D , *Professor of Radiology,* and CARL L GILLIES, M D , *Associate Professor of Radiology, State University of Iowa College of Medicine*

THE
URINARY TRACT

A Handbook of
ROENTGEN DIAGNOSIS

by

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THE YEAR BOOK PUBLISHERS INC
304 South Dearborn Street Chicago

PRINTED IN U S A

DEDICATED TO THE

MEMORY OF

PRESTON M HICKEY

PHYSICIAN TEACHER SCHOLAR

Preface

SINCE ITS DISCOVERY the roentgen ray has assumed an increasingly important role in the study of the urinary tract. Several books on the subject are available. It seems to us however that there is a place for a low priced handbook in which the roentgen appearances of the more common and some of the uncommon lesions are available for ready reference to the student practitioner urologist and radiologist.

It is difficult for radiologists not to be unduly influenced by the radiographic findings We wish to emphasize, therefore that in determining the status of the urinary tract it is necessary to correlate all clinical and laboratory data with the roentgen findings before arriving at a final diagnosis In every case illustrating pathologic involvement, we have examined the hospital record of the patient and it is to a large extent upon the study of all available information that our diagnoses have been based We believe however that a too lengthy discussion of the clinical and laboratory data would defeat the purpose of a book of this type and we have therefore stressed the radiographic findings

Because no two lesions or in fact no two normal structures appear exactly alike we have shown several examples of every condition wherever possible Likewise we have included unrelated conditions which may resemble urinary tract lesions or at least are frequently encountered in the roentgenographic examination of the urinary tract.

We have used only cases studied radiographically at the State University of Iowa Hospitals. While the available material is extensive it is not all inclusive We believe however that only a few of the extremely rare conditions have escaped our observation

In order to demonstrate better the reproductions of the radio-

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graphs, we have arbitrarily divided the book into sections on the kidney, ureter, bladder and urethra. By including only the pertinent segment of the urinary tract in the illustrations, less reduction in size has been necessary. All reproductions show the structures at 37 per cent of actual size. Necessity has forced us to do all the photographic work ourselves. No retouching or photographic dodges have been employed.

Without the careful and thorough study of the patients by the Department of Urology, this book would not be possible. Not only have we been permitted free use of their records, but the advice and assistance of Dr. N. G. Alcock and Dr. Rubin H. Flocks have frequently been requested and always willingly given. We therefore feel deeply indebted to the Department of Urology and to Dr. Alcock and Dr. Flocks in particular and wish to express our appreciation and gratitude for their help. Mr. H. A. Simons and the staff of the Year Book Publishers have co-operated fully in the preparation of this book and are also deserving of our sincere thanks for their able assistance.

We appreciate the fact that the information contained in this book is a synthesis not only of our own observations but also of those of many urologists and radiologists of the preceding decades. With familiarity bred of daily contact and discussion of a subject, it must be granted that it is frequently impossible to determine whether opinions are based on original observations, independent or otherwise, or whether they are based on ideas transmitted from our preceptors and accepted as our own when the source of information has become vague or forgotten. To this group of unnamed and sometimes unknown observers, without whose work the picture would be much less complete, we also wish to acknowledge our debt.

—H. D. K.
—C. L. G.

Iowa City, Iowa
June, 1944

The Bladder

The Ureter

The Bladder

The Urethra

Introduction

IT IS NOT always possible or practical to prepare patients for roentgen examination of the urinary tract. Particularly is this true when such attempts at preparation frequently result in the accumulation of more gas and fluid in the intestines than was previously present. Because of this routine preparation is not employed in this hospital Technical procedures should be scrupulously controlled. This means

1. Immobilization by a compression band and instructions to the patient about holding his breath
2. Selection of technical factors based on measurement of the patient
3. Careful inspection of accessories and particularly the avoidance of use of intensifying screens that are worn or stained
4. Careful positioning
5. The taking of a sufficient number of films

The preliminary or flat film is a prerequisite to practically every radiographic examination of the urinary tract. It usually does not give all the information desired, but it forms a basis from which to proceed A plain film of the urinary tract should include all of the tract. Both kidneys should be outlined so that their size shape and position can be determined. Both psoas shadows should be seen. The outline of the bladder can frequently be observed particularly if it is distended. Many lesions of the urinary tract may be suspected, diagnosed or ruled out from films of the urinary tract obtained without contrast medium. Ruling out a lesion may be as valuable as making a positive diagnosis

Urinary calculi are perhaps the most frequent lesions observed on the plain film. Abnormal calcifications such as are seen

with tuberculosis of the kidney or renal tumor, are readily discernible, although the exact diagnosis may not be apparent Tumors and cysts of the kidney can frequently be recognized by the distortion of the renal outline or the actual visualization of the tumor Anomalies of form and position, such as the horseshoe or fused kidney, can at times be seen on plain films, and likewise ectopy or agenesis may be suspected from failure to visualize the renal shadow

The Kidney

THE NORMAL KIDNEY The shadow of the normal kidney can usually be seen on a radiograph of good quality be cause the adipose capsule is less opaque to the roentgen rays The kidney has a well known and characteristic shape The longitudinal axis is normally directed downward and lateral and the transverse axis backward and lateral The position usually varies with the habitus of the individual, however, and is rela tively higher in the sthenic than in the asthenic

With the patient supine, the kidneys usually lie between the level of the upper border of the eleventh dorsal and the lower border of the third lumbar vertebra, and the right kidney usu ally lies slightly lower than the left There is normally a slight shift in position with respiration and change of position of the patient

THE NORMAL RENAL PELVIS The radiographic anatomy of the normal renal pelvis is best studied by means of retrograde pyelograms, using a contrast medium of increased density, although air may also be used as a less dense contrast substance Retrograde pyelograms distend and to some degree distort the pelvis, but the better filling and increased density of the contrast medium usually give better diagnostic radiographs Excretory pyelograms may be adequate for the study of the normal pelvis or congenital anomalies without other disease Frequently with disease, however, there is limited or absent function so that the excretory urograms may be indeterminate We have shown retrograde pyelograms wherever possible, therefore, because they not only have better reproducing qualities but on the whole also give more information

The renal pelvis and calices show great individual variation While all normal pyelograms more or less resemble each other, no two kidneys are ever quite alike The normal pyelogram must, therefore, become a concept rather than a well defined entity

In general, the renal pelvis is conical and its apex is continu ous with the ureter The base is directed upward, outward and backward, and there are usually two, perhaps three or even four, major calices branching from it From six to 12 minor calices may be seen arising from the major calices These likewise show

great variation in size shape and distribution as well as in number

The pyelograms shown on page 19 are considered normal One sees that the pelves vary greatly in shape as well as in capacity The upper and lower major calices are usually easily identified as can be observed on all the pyelograms It is at times difficult, however to distinguish a middle major calix from a minor calix which arises from the pelvis or from another major calix close to the pelvis

It is of little importance in an individual case if one is un able to determine the number of major or minor calices from the pyelogram. Some are likely to be obscured by the opaque material when the calix lies either directly in front of or behind the pelvis. Obviously those shown in profile and without super imposition are seen best.

The term calix means "cup" and the minor calices are in fact cup-shaped, with the renal papillae projecting into the out er or open end. The brim of this cup or fornix is normally well defined and sharp although it too varies in size and thickness in different individuals and in different phases of peristalsis. The determination of the sharpness of this brim is important for the first sign of disease may be the blunting of a minor calix. The calices vary in size not only in different kidneys but often in the same kidney When seen end-on a calix appears as a circle with a less dense center When it is superimposed over a portion of the pelvis a circular shadow of double density is formed and must not be mistaken for a calculus

[Normal renal pelvis *continued on page 18*]

The pyelograms shown opposite are considered not only normal, but typically so, without unusual variations

A —Normal retrograde right pyelogram showing three major calices The minor calices are sharp and clear-cut

B —Normal retrograde right pyelogram One minor calix viewed end-on (en face) appears as a circle with a less dense center owing to the papillary impression One minor calix is in full profile and shows a normal crescent shape with sharp borders

C —Normal retrograde right pyelogram showing slight variation in appearance from the preceding

D —Normal retrograde left pyelogram showing calices sharp and clear-cut The minor calices vary in size

E —Normal retrograde left pyelogram The major calices are short and the pelvis is proportionately large

F —Normal retrograde left pyelogram showing a small pelvis which is essentially a continuation of the ureter

G —Normal retrograde pyelogram showing variation in size of the minor calices All are sharp and there is no blunting of the fornices

H —Normal retrograde right pyelogram showing two major calices The minor calices show variation in size

I —Normal retrograde right pyelogram showing an ill-defined lower major calix but a well outlined upper major calix


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C
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VARIATIONS The pyelograms opposite are of patients for whom a diagnosis of no renal disease was made after consideration of all clinical and laboratory data We consider them normal variations, although some approach the abnormal

A —In this retrograde right pyelogram, the necks (infundibula) of the minor calices are unusually long, and the upper portion of the pelvis is distorted by the stiff catheter

B —The upper ureter is coiled on itself This is perhaps the result of slight ptosis of the kidney in addition to fixation of the lower ureter by the catheter Such an appearance should not be confused with a stricture, which finding persists on repeated examinations and is accompanied by signs of obstruction

C —The minor calices appear to arise directly from the pelvis, with no well defined major calices present

D —This entirely normal pyelogram shows unusually sharp minor calices with prominent renal papillae, due probably in part to an emptying phase of peristalsis of the minor calices

E —A minor calix is superimposed on the upper major calix, giving a dense circular shadow The upper end of the ureter is also looped on itself, producing an optical cross-section The stiff catheter is responsible for this finding These normal shadows are frequently mistaken for stones by the novice

F —The ureter shows an unusual attachment to the pelvis, and there appears to be some rotation of the kidney

G —This pelvis is bifid but has one ureter—a common congenital, but entirely normal, variation

H —Here the major calices are unusually broad and short, with the minor calices set deep into them

I —This pyelogram shows a pelvis which is slightly larger than usual, but the minor calices are sharp and clear-cut The clinical and laboratory findings were entirely negative


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PYELORENAL BACKFLOW Pyelorenal backflow is a general term applied to the phenomenon occasionally seen in retrograde pyelography in which some of the injected medium has passed outside the pelvis and calices

Four possibilities are recognized, and each may occasionally be detected *on retrograde pyelograms These are*

1 Pyelovenous backflow
2 Pyelolymphatic backflow
3 Pyelotubular backflow
4 Pyelo-interstitial backflow

There is not entire agreement as to the mode of production of the various types of pyelorenal backflow, even though there has been an active interest in the subject and excellent experimental and clinical studies have been made by Hinman, Lee-Brown, Abeshouse, Narath, Williams and many others

Venous, lymphatic and interstitial backflow are generally believed to occur following rupture of a calix in the region of the fornix Experimental evidence has been advanced both for and against this belief *It is almost universally agreed, however, that* pyelotubular backflow can occur from overdistention alone without rupture or renal disease In fact, the tubules of the pyramids have been visualized on excretory pyelograms This does not necessarily indicate a backflow, but shows that the tubules may be of sufficient size to be visualized without distention beyond that of excretory pressure

Pyelorenal backflow as *observed on ordinary retrograde pyelo*grams is probably not of much clinical significance, provided a nontoxic medium has been used In cases showing lymphatic backflow, it is perhaps advisable to rule out the possibility of chyluria, which has been found in patients with this phenomenon

1 Pyelovenous backflow as observed on retrograde pyelograms is recognized by the visualization of one or more of the arcuate veins of the parenchyma These have a fairly characteristic position, shape and anastomosis The arcuate veins lie in close proximity to the fornices of the calices and are probably filled by direct rupture into the vein When the veins are visualized,

the opaque material of the pyelogram extends outward at right angles to the brim of the calix in the form of a cordlike band which then curves back toward the long axis of the calix and anastomoses with its fellow of the opposite side The complete loop may be visualized and with it the secondary interlobular veins which enter the arcade at right angles

2 Pyelolymphatic backflow in retrograde pyelography is recognized by the visualization of the lymphatic channels as they pass medial and usually upward from the hilum of the kidney toward the para-aortic lymph nodes They appear as multiple threadlike lines of increased density 1–2 mm in diameter and follow a wavy course Small lymph nodes are also frequently visualized These are seen as localized enlargements along the course of the lymphatics The channels usually show a change in direction as they leave the node. Perivascular or parenchymal channels within the kidney are difficult to see since they may be overshadowed by accompanying pyelovenous or pyelo-interstitial collections of the opaque medium.

3 Pyelotubular backflow is probably the only form in which there is a backflow in the true sense of the word The tubules are filled in a retrograde direction from the calix through their natural openings in the papilla This is shown on the pyelogram as a sunburst effect extending from the calix into the renal pyramid. Usually this backflow extends only into the medulla although at times it may also involve the cortex.

4 Pyelo-interstitial backflow or the extravasation of fluid in the interstitial renal tissue is characterized only by the lack of the regular form that is observed in the other three types It occurs as irregular collections of opaque material and is influenced by the shape of the interstitial space which it occupies. When the extravasated fluid reaches the intact capsule it assumes the contour of the kidney at this point. If the capsule is ruptured, however the opaque medium has an amorphous appearance as it diffuses into the perirenal space

[Backflow *continued on page 24*]

PYELOVENOUS BACKFLOW *A*.—This demonstrates a complete venous arcade forming a circle which arises from the fornix of a minor calix There is also extravasation into the renal sinus This patient, aged 69, was seen because of a tabetic crisis No renal disease was found

B.—At least three minor calices in the upper half of the kidney show partial filling of the arcuate veins This patient was a man aged 51 with a prostatic abscess The upper urinary tract was normal

PYELOLYMPHATIC BACKFLOW *C*.—The tip of the catheter appears to have pierced the infundibulum of a minor calix The lymphatic channels medial to and above this are outlined as threadlike shadows Small nodes are visualized and the channels change direction as they leave the nodes The patient was a man aged 58 with pulmonary tuberculosis who was studied because of hematuria Cystoscopy showed that the blood came from the opposite, or right, side The urine from the left kidney was normal

D.—The pelvis and calices appear fully distended, and the lymphatic channels are visualized medial to the upper pole of the kidney as they course medially and upward At least one lymph node is visualized The patient was a woman aged 60 with hypertension of 15 years' duration The right or opposite side showed infected hydronephrosis The urine from the left kidney was normal Blood pressure was 220/130

[Backflow *continued on page 26*.]


B
C
D

PYELOTUBULAR BACKFLOW *A*—This pyelogram shows a fully distended pelvis and calices and small tufts of opaque medium extending into the papillae from several of the calices This patient was a man aged 51 with Hodgkin's disease The urinary tract was studied and the findings were negative

B—This excretory pyelogram shows the tubules as they empty into each minor calix On the original film, definite striations can be seen as a sunburst effect from each calix This does not necessarily mean that there has been overdistention of the renal pelvis in this instance, but that the tubules are of sufficient size to be visualized without distention beyond that of excretory pressure The patient was a woman aged 63 with two small stones in the lower pole of the right kidney The left kidney, in which the tubules were not visualized, had a larger stone in the pelvis with hydronephrosis

PYELO-INTERSTITIAL BACKFLOW *C* — In this retrograde pyelogram, the tip of the catheter appears to have penetrated the pelvic wall and to have allowed extravasation of the opaque material into the interstices of the kidney

D—This film, made shortly after *C* and immediately following washing of the pelvis, demonstrates the remaining opaque material as an irregular collection within the interstitial tissues The advantages of using a nontoxic and absorbable substance in pyelography is at once apparent The patient was a man aged 40 who was seen because of renal colic on the right, or opposite, side The urologic studies of the left side were normal


A
B
D

PENETRATION BY CATHETER There is some question as to whether or not a catheter can ever pierce a normal renal pelvis We are of the opinion that it can, although others maintain that it is only in the presence of accompanying disease that this can occur

A—In this retrograde left pyelogram, the ureteral catheter has pierced the pelvis so that at least half of the injected opaque medium has passed into the interstitial tissue and has been limited by the renal capsule, thereby outlining the lower pole of the kidney

B—A lateral pyelogram of the same patient, taken immediately after *A*, shows the fluid pocketed along the posterior surface of the kidney and limited by the overlying renal capsule This patient was a girl aged 1 year who was seen because of a protuberant abdomen The pyelogram was made to rule out renal tumor There were no urinary symptoms or findings A diagnosis of xanthomatosis with enlargement of the liver was made later

C—A catheter has pierced the pelvis and parenchyma to the capsule The opaque medium was injected without withdrawing the catheter, so it appears that the injected fluid has followed along the path of the catheter into the pelvis without appreciable extravasation The patient was a man aged 34 who gave a history of intermittent hematuria for two months without other symptoms The urinary examination showed no blood, and the pyelogram was considered normal

PENETRATION OF PARENCHYMA AND CAPSULE Rarely in retrograde pyelography a ureteral catheter will pierce not only the pelvis but also the parenchyma and capsule

D—A ureteral catheter is piercing the renal pelvis, parenchyma and capsule None of the injected opaque medium is in the pelvis, but all lies in the perirenal space This patient was an obese woman aged 58 with cystitis No signs or symptoms referable to the perirenal injection of the skiodan developed She was again seen three months later and a retrograde left pyelogram was normal


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C
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CONGENITAL ANOMALIES The congenital anomalies of the kidney have been conveniently divided by Hinman into those of *number, size, form, position, blood supply* and *structure*

I *Number* Congenital agenesis of both kidneys occurs, but since it is incompatible with life, it is only of academic interest Congenital agenesis of one kidney is important, however, particularly when there is suspected disease of the existing kidney Except for evidence of hypertrophy of the existing kidney, the roentgenographic findings in congenital agenesis are entirely of a negative character The diagnosis should not be made because of failure to visualize a renal shadow, even after excretory pyelograms On the other hand, the roentgenographic findings are of value when correlated with other information, particularly that obtained from cystoscopy

Double or Duplex Kidney —This malformation, in which there is a reduplication of the renal pelvis, is one of the most common anomalies of the kidney This deformity ranges from slight variations in which the pelvis only is bifid to complete reduplication of the pelvis and ureter The ureters usually join before reaching the bladder but may enter the bladder separately, or occasionally one may empty into the urethra or vagina Double kidney is most frequently unilateral but may be bilateral, the ratio being about 7 1

When both pelves and the ureters of a double kidney are visualized by excretory or retrograde methods, the diagnosis is obvious When only the lower pelvis is visualized, however, the diagnosis is more difficult The lower pelvis usually closely resembles a normal one, and while it may be slightly smaller, it is frequently well within normal limits It is only when the upper pole of the kidney is outlined that the anomaly is suspected, for then one sees a greater mass of renal tissue than can be accounted for by the visualized lower pelvis and calices The upper pole may be elongated, but the outline is smooth and the density is that of normal renal tissue This fact, together with the absence of deformity of the pelvis, tends to rule out organic disease in favor of this congenital anomaly When the upper pelvis alone is

visualized, the diagnosis of a double kidney is much easier The upper pelvis is usually small and lily-shaped and when the renal outline is visible it becomes obvious that the pelvis is too small for the size of the kidney The same holds for the more rare single budlike upper pelvis which is visualized only as a slight expansion of the ureter Except for being small the upper pelvis of a double kidney does not resemble that found in the hypoplastic kidney (*See also* illustrations pages 36 and 37)

II Size. Hypoplasia or agenesis of a kidney is usually associated with hyperplasia of the opposite kidney and both hypoplasia and hyperplasia may at times be visualized

Hypoplasia.—In congenital hypoplasia the renal shadow is usually difficult to see yet it is important to trace its outline at least in part if the condition is to be recognized. The kidney is always small and there is usually evidence of overdistention of the pelvis on the retrograde pyelogram Major and minor calices are uniformly small are set close together in the renal substance and occupy an area much smaller than that observed in the normal pyelogram Excretory pyelograms are valuable in that they show function in these kidneys and avoid the possibility of overdistention of the pelvis thus allowing a more exact determination of its size. The hypoplastic kidney and pelvis represent, in fact, a miniature of the normal kidney and in no way resemble the appearance of the small pelvis observed in the upper pole of a duplex kidney The latter shows normal-sized calices in a normal or elongated kidney whereas in hypoplasia there are small calices within a small kidney (*See also* illustrations, pages 38 and 39)

Hyperplasia.—Hyperplasia can at times be suspected from the radiograph because the renal shadow is larger than normal but since there is normally such a wide variation in size a diagnosis of hyperplasia must be made with extreme caution In true congenital renal hyperplasia the pelvis and calices are also large. Evidence of absence or underdevelopment of the opposite kidney should be obtained before making this diagnosis.

III Form Anomalies of form are frequent and compose an important group of congenital malformations This includes the

fused kidneys variously classified according to their shape as horseshoe, disk, sigmoid, etc. Some, such as in crossed ectopy, also fall into more than one classification, because they not only are abnormal in form but also occupy an abnormal position. The horseshoe kidney is the most common anomaly of this group. It is characterized by its horseshoe shape, which is due to fusion, usually of the lower poles across the midline. Not infrequently on radiographs of good quality the contour, including the bridge of tissue, can be made out. The pelves of the horseshoe kidney usually fail to rotate during fetal life as the kidney ascends from the bony pelvis. This causes the calices on each side to point posteriorly, while some actually lie medial to the pelvis. When the lower poles fuse, the axes of the pelves lie obliquely downward and medial rather than obliquely downward and lateral, as is normal. At least a portion of the pelves or calices usually lies near or over the spine. Retroperitoneal tumors, such as a mass of enlarged para-aortic lymph nodes, may displace and rotate the kidneys in such a manner as to simulate a horseshoe kidney. In this event, however, the pelves lie farther from the midline than they do with a horseshoe kidney or, as a matter of fact, farther from the midline than normal. (*See also* illustrations, pages 40 and 41.)

Fused Crossed Ectopy.—In this condition the ureters usually enter the bladder in normal positions, but both kidneys lie on one side. The crossed ectopic kidney lies below and is fused to the other kidney, which may occupy a relatively normal position or may be lower than normal. In crossed ectopy, not only is there an abnormal shape of the fused mass of renal tissue but the pyelograms show failure of rotation of the lower pelvis with usually some variation from normal in the position of the upper pelvis. Either failure of rotation or change in direction of the long axis of the pelvis, or both, may be seen. (*See also* illustrations, pages 42 and 43.)

IV. Position. Congenital abnormality of position must be distinguished from the acquired form of malposition.

Uncrossed Ectopy.—An uncrossed ectopic kidney is a kidney arrested somewhere along its normal course of ascent. It is charac

terized by its low position its failure of rotation and the anterior position of the pelvis with the calices pointing posteriorly The minor calices are usually visible both medial and lateral to the pelvis and the ureter is short and straight These kidneys may occur in any location between the bladder and the normal renal position. This type of congenital ectopy must be differentiated from the movable or ptotic kidney in which the kidney has at one time reached a normal position and later because of abnormal mobility has assumed its low location With the ptotic kidney the ureter is of normal length but shows kinking or coiling due to redundancy The kidney may be *tilted laterally so* that the long axis approaches the horizontal Films taken with the patient supine and upright will reveal this abnormal mobility (*See also* illustrations pages 42 and 43 50 and 51)

V Anomalies of Blood Supply Anomalies of blood supply are not apparent radiographically in the otherwise normal kidney but are a common cause of hydronephrosis and will be discussed under that heading

VI Structural malformation There is some disagreement regarding the congenital origin of certain structural malformations

Simple Cysts —Evidence has been put forth both for and against the congenital origin of simple cysts They may be either serous or hemorrhagic and are comparatively rare They usually arise in the cortex near the capsule but may occur in any location within the kidney Practically all of them are discovered in adults which is a point against their congenital origin Roentgenographically they are spherical with smooth outlines. They are slightly more dense than renal tumors and this density has the homogeneous appearance of fluid. This is distinctly different from the mottled density usually encountered in a tumor As a rule cysts attain considerable size before being discovered, and the deformity of the renal pelvis observed on pyelographic studies is likely to be less marked than one would expect with a tumor of the same size The deformity from a simple cyst is likely to be one of compression of the pelvis and calices without the elongation which is so frequently observed with neoplasm If the

cyst is located in one pole, however, it may attain considerable size without producing deformity of the pelvis This holds true even though its size and weight are sufficient to displace the kidney and change the renal axis On the other hand, large cysts may be so situated as to produce extreme pressure deformity of the pelvis Even though the pelvis and calices may be greatly deformed, their outline remains smooth, in contrast to the findings with tumor, which may invade the pelvis and frequently produces irregularity Calcification within a cyst is rare, and when it does occur it is in the wall of the cyst This is quite different from the calcification in a renal neoplasm, which is characterized by diffuse flecks, although plaques may also occur (*See also* illustrations, pages 44 and 45)

Polycystic Disease —It is well established that polycystic disease of the kidneys is congenital and familial, the disease has been reported in three generations of the same family The condition is usually discovered during two age periods first, in the new-born, who die as a result of the condition, and second, in people well past middle age, who usually show signs of renal insufficiency From a roentgenographic standpoint, we are concerned only with the latter group The condition is nearly always bilateral, and usually the kidneys show an equal degree of involvement Roentgenographically, both kidneys are usually of enormous size, the renal pelves are greatly elongated in the superior-inferior diameter, and yet in comparison with the increase in the size of the kidneys, the volume of the pelves appears relatively reduced and they may be narrowed in the transverse diameter On the other hand, the volume of the calices frequently appears to be more than that of the pelves The minor calices lose their usual cup shape and become flattened and distorted by pressure from adjacent cysts Arc shaped depressions are observed in many of the calices Pyelograms of polycystic kidneys are usually similar, so that when once recognized the diagnosis of typical cases is not difficult (*See also* illustrations, pages 46–49)

[Anomalies *continued on page 36*]

DOUBLE KIDNEY *A* — This retrograde pyelogram shows a typical upper renal pelvis and calices of a double kidney This pelvis is obviously too small for a normal-sized kidney

B —This demonstrates the lower pelvis of the same kidney The pyelogram appears entirely normal, and one can easily understand the difficulty of making a diagnosis of a double kidney if this pelvis alone were visualized It is only when the outline of the upper pole of the kidney is recognized on the film that the possibility of a duplex kidney can be suspected

C —This pyelogram shows both upper and lower pelves These three pyelograms were obtained during study of a girl, 18, who complained of pain in the left flank There were two ureteral orifices on the left One occupied a normal position, and when catheterized led to the upper pelvis The orifice of the ureter leading to the lower, or larger, pelvis was located in the bladder 1 in above the first As occurred in this case, it is usual for the ureter leading from the upper pelvis to empty into the bladder distal to the orifice of the ureter from the lower pelvis The left kidney had a single pelvis Renal function tests were normal on both sides

D —This shows bilateral double kidneys The four ureters opened into the bladder separately The upper pelves are represented by slight budlike expansions of the ends of the dilated ureters The patient was a woman aged 51 with an inoperable pelvic tumor Cystoscopy showed a large extravesical tumor elevating the trigone and base of the bladder It was thought that the tumor which apparently arose in the uterus was producing some obstruction of the ureters, and the pyelograms show obvious hydronephrosis Here again, it is apparent that with visualization of only the lower pelvis, the diagnosis of a duplex kidney cannot be made unless the outline of the upper pole of the kidney can be seen

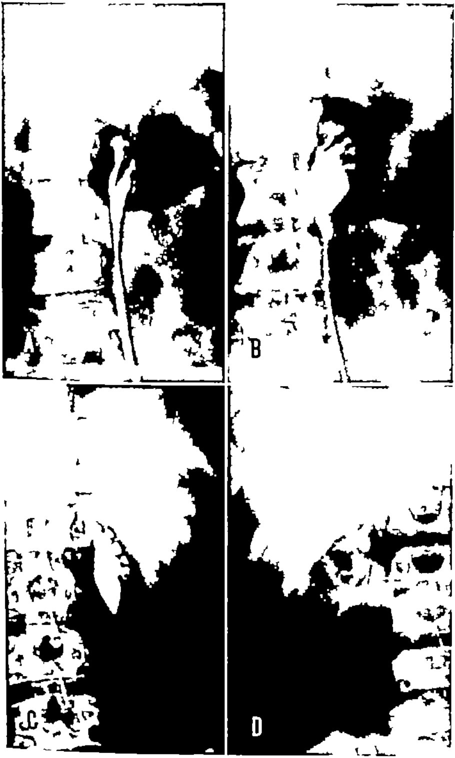

A
B
C
D

HYPOPLASIA *A*.—This pelvis is of the bifid type The pelvis and calices are of fairly normal appearance except for the small size The renal outline, apparent on the original film, showed only a small band of tissue surrounding the calices The patient was a girl aged 14 with ulcerative colitis While in the hospital, pus appeared in the urine and this called attention to the urinary tract Cystoscopy showed normal ureteral orifices The left ureter was catheterized, but no urine was obtained Only 5 cc of opaque medium was injected, and this small amount obviously distended the pelvis

B.—This retrograde pyelogram shows miniature major and minor calices The pelvis, which appears extrarenal, is obviously overdistended The patient was a woman aged 51 with hypertensive cardiovascular disease She was the mother of seven children and stated that she had had pyelitis accompanying each pregnancy and several additional attacks Both ureters were catheterized There was a normal flow of urine from the right side, but none from the left

C.—This retrograde pyelogram shows a miniature kidney with small, closely spaced calices, but with obvious overdistention of the calices and pelvis The renal outline on the original film corresponds in size to what would be expected with such a small pelvis The patient was a woman aged 30 with psychoneurosis but no urinary symptoms Excretory pyelograms showed ptosis with mild hydronephrosis on the right and a small pelvis on the left Retrograde pyelograms were then made Cystoscopically there was no evidence of a double kidney Only a single ureteral orifice could be found on each side

D.—In contrast to the other films shown here, this excretory pyelogram does not show overdistention of the pelvis or calices They are normal in appearance except for their small size The patient was a boy aged 11 with diabetes He also had hypospadias with dribbling, but there were no other urinary symptoms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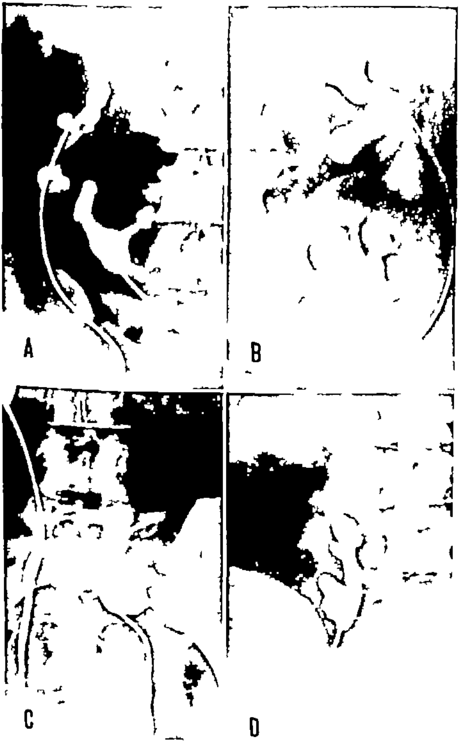
HORSESHOE KIDNEY *A*—These bilateral retrograde pyelograms show a typical horseshoe kidney The long axes of the renal pelves are tilted downward and medial owing to the fusion of the lower poles across the midline Also because of the fusion, the kidneys have failed to rotate so that the pelves occupy an anterior position, with the calices pointing posteriorly At the lower poles the calices are seen medial to the lower pelves and upper ureters The patient, a man aged 32, had pain in the left side of the abdomen and gave a history of having passed stones from the left kidney three years before Results of the urologic examination were negative except for the horseshoe kidney

B—These retrograde pyelograms again show the appearance typical of horseshoe kidney, with the change of pelvic axes, bridge of tissue across the midline, failure of rotation and visualization of the lower calices medial to the pelves and nearer to the mid line than normal The patient was a man aged 60 with no urinary symptoms Finding of the horseshoe kidney was incidental to the study of a metastatic adenocarcinomatous mass in the omentum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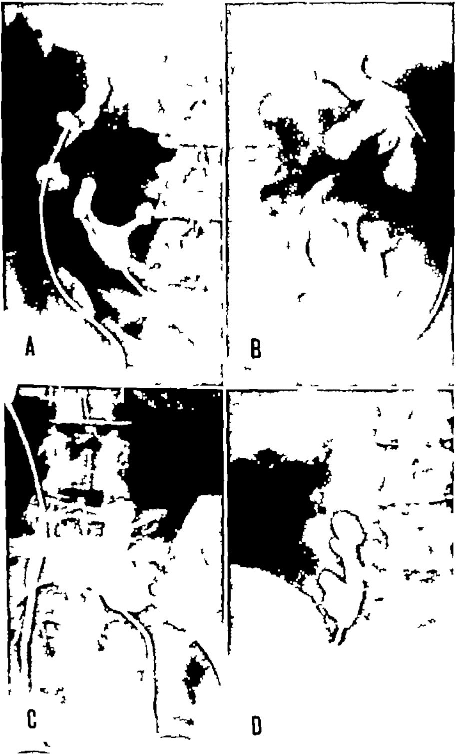
CROSSED ECTOPY *A* —Both kidneys lie on the right side much below the normal position, yet the ureters are not tortuous and they leave the pelves in the dependent position The kidneys show failure of rotation, and from the proximity of the pelves it can be assumed that they are fused Aside from the abnormal position and apparent fusion, the pelves and calices show no deformities This patient was a woman aged 47 with no urinary symptoms She was examined by the Department of Urology only because the fused kidneys formed a palpable mass in the right lower quadrant Results of the urinary examination were negative Cystoscopically, the ureteral orifices were in normal positions

B —This pyelogram demonstrates fusion of the kidneys on the left, with failure of ascent and rotation of both kidneys The ureters are comparatively short and not tortuous This patient was a man aged 69 who had symptoms and findings of prostatism He gave a history of attacks of sharp pain in the left renal area with radiation to the groin A stone was found in each renal pelvis

UNCROSSED ECTOPY *C* —An unascended left kidney lying at the level of the sacrum The pelvis is anterior and the ureter, which enters the bladder in its normal position, is short and straight The patient was a woman aged 38 Aside from the ectopy, there were no abnormal findings in the urinary tract

D —This retrograde pyelogram shows an unascended right kidney with anterior location of the pelvis and a short, straight ureter The patient was a woman aged 26 with attacks of recurrent pain in the right lower quadrant Appendectomy four years previously for similar pain had given no relief Repeated urinary examinations gave negative results



CYST *A*—This bizarre pyelogram shows the kidney replaced by a diffuse homogeneous shadow The calices are elongated and compressed but are smooth and show no evidence of invasion The patient was a woman aged 33 with a mass in the left side for six years There were no urinary symptoms At operation, 2,200 cc of clear fluid was aspirated from the cyst before the kidney was removed Pathologic diagnosis was multiloculated cyst of the kidney

B—This retrograde pyelogram shows marked elongation of the upper major calix with distortion of this major and its minor calices around a spherical homogeneous mass of greater density than the kidney The patient, a woman aged 53, had had no urinary symptoms The kidney was removed Pathologic diagnosis was simple cyst of the kidney

C—A large soft tissue mass is present below the kidney The weight of the mass apparently causes the renal pelvis to tilt lateral and downward There is no pressure deformity of the adjacent pelvis or calices The mass is of uniform density, although the overlying bowel does produce some mottling Fluoroscopic examination of the visualized pelvis showed that the kidney moved with the abdominal tumor The patient was a woman aged 44 with a mass in the right side for one and a half year She was asymptomatic, and an operation was not performed

D—This retrograde pyelogram shows a mass in the upper pole of the right kidney, elongation and separation of the upper major and minor calices and compression and elongation of the middle major calix The pelvis and calices appear smooth and uninvaded This pyelogram is more suggestive of a renal tumor than of a cyst, which it proved to be The patient was a woman of 63 with a two year history of gross hematuria For seven months there was no change in the appearance of the renal lesion However, hematuria developed which required nephrectomy Pathologic diagnosis was solitary cyst of the kidney and chronic pyelonephritis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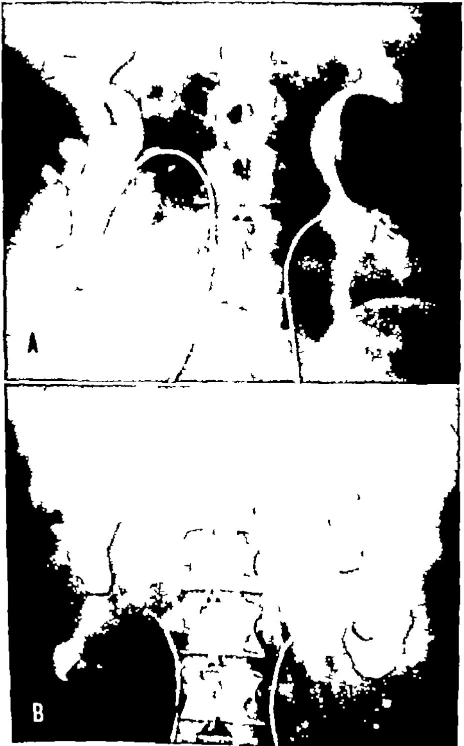
POLYCYSTIC DISEASE *A*.—These bilateral retrograde pyelograms show enormous kidneys. The pelves are greatly increased in their superior-inferior but not in their lateral diameters. The minor calices are distorted by the cysts, yet the margins are sharp and angular and there are no findings suggesting hydronephrosis. The patient, a woman aged 62, discovered a mass in the right flank two years before. There had been no urinary symptoms. Both kidneys were readily palpable, enlarged and irregular. No albumin was found in the urine. The blood pressure was 195/90. The patient had one brother with "kidney disease." She had five children living and well and had had one miscarriage.

B.—These retrograde pyelograms illustrate very large kidneys. The pelves are narrow, with a capacity less than normal and less even than that of the calices. The minor calices, while distorted by pressure, still show angular outlines. Pressure defects in the major calices are also apparent. The patient was a woman aged 31 who complained of intermittent hematuria for several years, shortness of breath and pain in the right flank. Examination showed bilateral irregular masses in both flanks which moved on respiration. The blood pressure was 230/130. She knew that she had had high blood pressure since a pregnancy six years before. She also had chronic uremia, and the urine showed considerable albumin.

[Polycystic disease *continued on page 48*.]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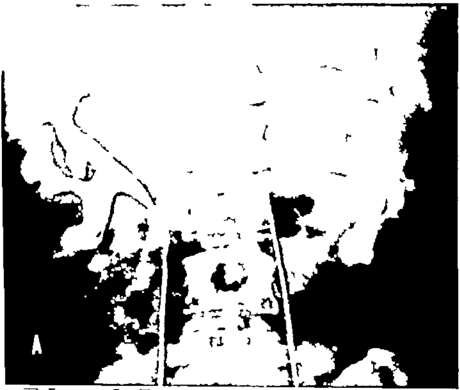
A.—Retrograde pyelograms of bilateral polycystic kidneys again show large kidneys with relatively small pelves. Although distorted, the minor calices show sharp, angular margins with no suggestion of "clubbing." The patient, a woman aged 47, complained of increasing weakness, recurrent dull, aching pain and a mass in the left side. Both kidneys were palpable and enlarged. The blood pressure was 170/98 and had been elevated for at least two and one-half years. Examination of the urine showed a small amount of albumin. Renal function on both sides was poor.

B.—Film of the upper abdomen showing pyelograms typical of bilateral polycystic kidneys. The patient was a woman aged 31 for whom a diagnosis of polycystic kidneys had been made five years previously. There was a large amount of albumin in the urine and the blood pressure was 140/100. The patient died of uremia two weeks later. Autopsy showed bilateral polycystic kidneys. The right weighed 1,600 Gm. and the left 1,200 Gm.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MOVABLE KIDNEY The kidney is normally a somewhat movable organ, but abnormal mobility does not necessarily produce symptoms In suspected cases of movable kidney, pyelograms should be obtained with the patient in both supine and upright positions

With the patient supine, the movable kidney usually occupies a normal position With the patient upright, however, the kidney descends and is likely to tilt, while the ureter may be kinked or tortuous If the ureteropelvic junction is fixed by an aberrant vessel or a fibrous band, there may be obstruction with resulting hydronephrosis As previously mentioned, the ectopic kidney, which may be confused with a low movable kidney, is low in both the supine and upright positions and has failed to rotate so that the pelvis is anterior and the ureter is short and straight

A—Low kidney with long coiled ureter in a 100 lb undernourished woman aged 42 with visceroptosis On visualization, the gallbladder was found below the pelvic brim Both kidneys were palpable There were no urinary symptoms

B—Retrograde pyelogram showing mild hydronephrosis in a woman aged 45 who had had recurring attacks of pain in the right loin Between supine and erect positions there was 7 cm movement of the kidney A nephropexy was done, and at operation the kidney was normal in appearance but had a long pedicle and was freely movable There were no aberrant vessels obstructing the ureteropelvic junction, nor was there any evidence of stricture in this region

C—Retrograde pyelogram taken with the patient supine The patient was a woman aged 42 who complained of "deep," nonradiating pain in the right side for four years For two years the pain had been almost continuous when she was active but was relieved when she was lying down The right kidney was palpable and movable

D—Pyelogram of the same patient taken in the erect position This demonstrates unusual mobility of the kidney A corset gave the patient complete relief


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NEPHROLITHIASIS Renal calculi are usually composed of mixtures of chemical substances excreted in the urine Fortunately, from a radiographic standpoint the great majority of these stones contain a sufficient amount of calcium in the form of oxalate, phosphate or carbonate to be visible on the plain radiograph Rarely, nonopaque stones do occur They are composed of uric acid, urates, cystine, xanthine, cellular debris, fibrin or bacteria, with little or no calcium, and are of a density approaching that of soft tissue To this latter group must now be added the sulfonamide precipitations in the urine during treatment with these drugs

While in most instances a presumptive diagnosis of renal lithiasis can be made from the plain film, the chances of error and what it implies are usually sufficient to warrant complete radiographic and urologic studies With the exception of the stag-horn and calcium oxalate stones, most renal stones can be simulated by unrelated concretions and calcification Typical biliary calculi, calcification of the gallbladder, blood vessels and lymph nodes and ossified costal cartilages are usually easily identified Atypical lesions, however, may easily be confused with renal calculi. Renal calculi are most commonly single, but they may also be multiple and either unilateral or bilateral The appearance of a calculus is influenced not only by its composition but by its location and fixation, i e, a calculus that lies free in the renal pelvis or a calix is likely to be round or oval owing to the free movement which allows salts to be deposited uniformly over its surface Laminations are common When a stone in a calix becomes large enough to impinge on the calycine walls, its shape conforms to the space that it occupies, i e, it may be shaped like a calix or it may form a complete cast of the pelvis and calices These large branching or stag-horn calculi have a typical appearance not simulated by any other lesion, and an unqualified diagnosis can be made from the plain film Likewise, the "mulberry" calcium oxalate stone has a typical appearance which is due to its crystalline form Stones originating from mural plaques, as many of them do, are likely to be flat or irregular on one side after they have become detached This irregu-

larity or flattening can frequently be observed on a radiograph if the stone is seen before too much additional urinary salt has been deposited on it. Following the deposition of such salt the stone becomes round or oval if it lies free. Multiple calculi which lie free in the pelvis or in a calycine diverticulum are likewise usually round or oval. Faceted calculi do occur but are rare. To diagnose a renal calculus, one must be sure that the shadow in question lies within the pelvis, a calix or parenchyma of the kidney and is not a manifestation of other renal disease, such as calcification within a tumor or that produced by infection. It is therefore often advisable to take films in different phases of respiration. A renal calculus will retain a constant relationship to the outline of the kidney, whereas extraneous shadows such as calcified nodes, gallstones and calcified costal cartilages will show a shift in position in relation to the renal contour. Oblique lateral or postero-anterior films will accomplish the same end. Pyelograms are frequently indicated to establish the exact location of a suspected lesion. An opaque pyelogram may completely obscure a suspected calculus if it is of the same density. However, superimposition of the images of the plain film over the pyelogram will usually establish the exact location. The obliteration of the shadow by the pyelogram is in itself of diagnostic importance. If a stone in the pelvis or a calix is of different density and of sufficient size, it will show as a filling defect. Information regarding the state of the pelvis itself can also be obtained by pyelography, and this is important because a pelvis may be damaged in the presence of stones.

Nonopaque calculi can be identified by pyelographic studies only when they appear as filling defects in a medium of greater or lesser density. The use of air as a contrast substance may be advantageous, particularly in the presence of small stones, since the surrounding air does not obscure the shadow cast by the stones, which may be the case if an opaque medium is used.

[Nephrolithiasis *continued on page 54*]

NEPHROLITHIASIS Renal calculi are usually composed of mixtures of chemical substances excreted in the urine. Fortunately, from a radiographic standpoint the great majority of these stones contain a sufficient amount of calcium in the form of oxalate, phosphate or carbonate to be visible on the plain radiograph. Rarely, nonopaque stones do occur. They are composed of uric acid, urates, cystine, xanthine, cellular debris, fibrin or bacteria, with little or no calcium, and are of a density approaching that of soft tissue. To this latter group must now be added the sulfonamide precipitations in the urine during treatment with these drugs.

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A.—This single calculus has the "mulberry" appearance which is characteristic of a calcium oxalate stone. This should not be confused with any other shadow. It can be formed only in the urinary tract, and consequently its visualization is prima facie evidence of a urinary calculus. From the plain film alone, it is obvious that this stone is too large to occupy a normal calix and is probably, therefore, within the pelvis. This was proved by pyelographic studies and operation.

B.—This oval stone is slightly irregular in outline and can be considered a typical renal calculus. The outline of the kidney is visible, and it is observed that the stone lies in the region of the pelvis. This location was confirmed by pyelograms. Pelviolithotomy was done. Analysis showed the stone composed largely of calcium phosphate. Incidentally, an optical section of a calcified renal artery (arrow) overlies the upper pole of the kidney.

C.—This small slightly irregular but nearly round stone is of uniform density. From its size, this stone might readily occupy any portion of the pelvis or calices and obviously may shift with change of position of the patient. In fact, a stone of this size should pass down a normal ureter. The shadow of a stone of this size can easily be wiped out by slight respiratory movement. This is a technical point which should be carefully controlled. The patient, a woman aged 36, had normal pyelograms.

D.—A medium-sized oval, laminated calculus fills the upper portion of the renal pelvis. The lower portions of the pelvis and calices are filled with opaque medium and are hydronephrotic. The upper major calix is almost completely occluded by this stone. The stone was removed by pelviolithotomy. Analysis showed the stone composed largely of calcium phosphate.


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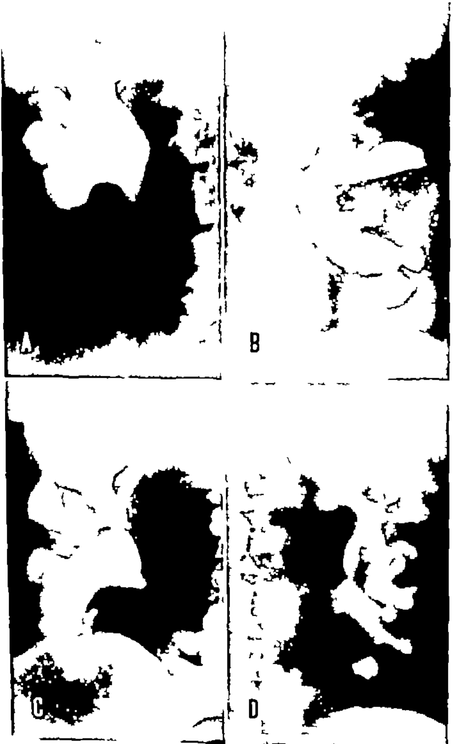
MULTIPLE CALCULI Multiple renal stones in the pelvis are likely to be round, not only because of rubbing against each other but because the urine can reach all surfaces equally and accretion proceeds uniformly. On the other hand, multiple stones which occupy the calices are likely to be irregular. In this location it is probable that the enlargement of the stones does not occur equally on all sides unless the stones are free and are small enough to rotate.

A.—This flat film of the left renal area demonstrates multiple faceted calculi having more the characteristics of biliary than of renal calculi, that is, they are faceted and show a dense outer ring surrounding a less dense ring but have opaque centers. Had these stones been on the right side, the differential diagnosis would have been more difficult. The patient, a woman of 53, had had an attack of colic 20 years before but had had no further trouble until one year before admission. When removed, these stones were soft but definitely faceted.

B.—This radiograph shows numerous widely separated stones of varying sizes and, for the most part, irregular shapes. The separation alone, even though the renal outline is not seen, permits one to deduce that the kidney is grossly enlarged, damaged and has a large pelvis. This patient, a man of 48, had had attacks of colic with passage of stones for 17 years. A left pelvi-olithotomy was done, and a large infected hydronephrosis with much thinning of the renal tissue was found.

C.—Numerous round calculi are free in the pelvis. When stones are free and lie in close approximation, they are usually spherical and not angular and irregular. This patient, a man aged 79, was seen because of prostatism. He was observed for five years, during which time he passed several stones.

D.—Scattered, irregular stones are seen in the renal calices of a patient who had had progressive atrophic arthritis for 12 years. The radiographic diagnosis of stones had been made eight years before. The growth of the stones must have been exceedingly slow.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STAG-HORN, BRANCHING OR CORAL CALCULI

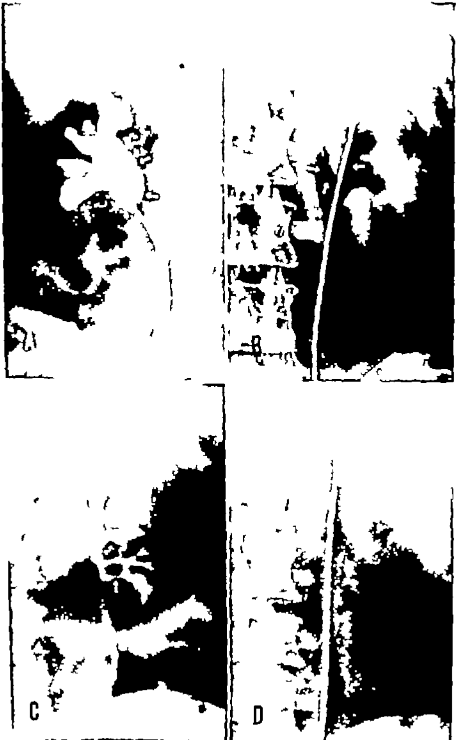
These stones have the most characteristic appearance of all renal calculi, forming as they do casts of the renal pelves and calices Some are single and complete, others appear to be fragmented, and still others seem to have developed from multiple centers Occasionally, stones of this type may fill only one or two adjacent calices Chemically, they are usually composed of calcium phosphate, but rarely they are largely made up of cystine The only possibility of error in diagnosis is in mistaking these stones for opaque pyelograms These stones are readily obscured by retrograde pyelograms because they are of about the same density as the usual pyelographic medium Large stag-horn calculi are frequently complicated by infection Serious accompanying renal damage is the rule rather than the exception, and perinephritic abscess is a common complication

A —A large stag-horn calculus forms a cast of the renal pelvis and calices From its size, it is obvious that there must be considerable renal damage This patient, a woman aged 66, had passed a stone 32 years previously

B —A large branching calculus fills the left renal pelvis and calices of a woman aged 59 who had only vague abdominal complaints

C —There is a large branching calculus of the right kidney The large size of the calyceine branches indicates that there must be extensive renal damage, with only a thin rim of renal tissue remaining This patient had had recurring attacks of pain for seven years and had advanced cardiorenal disease

D —A large fragmented calculus forms a cast of the left renal pelvis and calices This patient, a man aged 45, had passed a stone 18 years before and had been told that a radiograph 12 years before had showed a stone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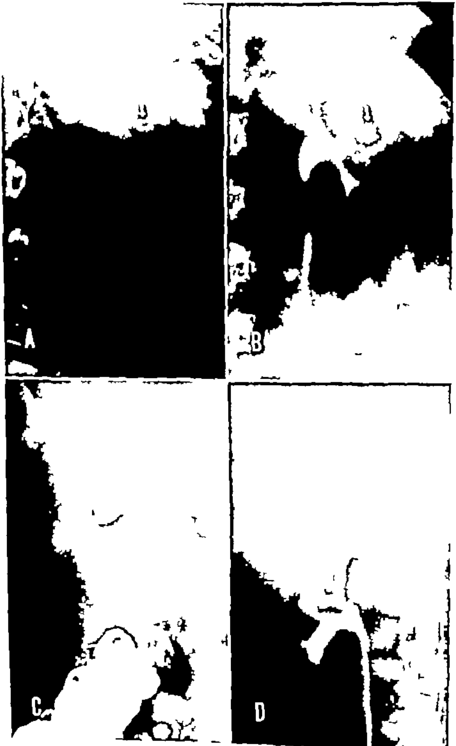
RENAL CALCULI OF LITTLE OR NO CALCIUM CONTENT On the plain film, calculi which contain little or no calcium are visualized poorly, if at all. Fortunately, from a roentgenographic standpoint they are not common in the kidney. Pure uric acid stones and the soft stones composed of cellular debris, clumps of bacteria or fibrin can be shown only as filling defects in opaque pyelograms or as positive shadows in air pyelograms. The use of air is perhaps the better method of demonstration, since it obviates the possibility of covering the stone with opaque medium and better delineates the calculus.

A.—This retrograde right pyelogram shows an irregular filling defect of negative density in the lower portion of the pelvis and adjacent major and minor calices. A pelviolithotomy was done, and a stone with a hard center composed of calcium oxalate and calcium phosphate was found. The outside was composed of fibrin, old blood clot and degenerated epithelium.

B.—This retrograde left air pyelogram shows a smooth shadow in the pelvis. On pelviolithotomy, squamous metaplasia of the pelvic epithelium was found; the "calculus" was made up of a mass of epithelial debris.

C.—In this retrograde left pyelogram, a rectangular filling defect is seen in the lower portion of the pelvis. In the center of the defect, a small fleck of calcium density can be made out. According to the researches of Randall, this probably represents the original nidus or plaque on which this stone was formed. The patient, a woman of 39 with rheumatic heart disease, had had a stone removed from this kidney three years previously. Following pelviolithotomy, the patient died of cardiac failure. At autopsy a mass of calculi was found in the lower left ureter. Microscopic examination of this material showed uric acid crystals, and we therefore believe the renal stone was also composed of uric acid.

D.—This retrograde left air pyelogram shows a small calculus of low density in the lower calix. Studies showed hydronephrosis and hydroureter from a congenital stricture of the ureter at its junction with the bladder. The stone was not removed.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CALYCINE DIVERTICULUM A calycine diverticulum is a parenchymal cavity which communicates with a calix and is usually filled with small calculi Prather has shown by microscopic study of the lining of these cavities that the membrane is similar to that of a normal calix While the exact etiology of this condition is in doubt, it is certainly a definite entity The cavity is usually filled by either retrograde or excretory pyelography The outline is smooth, and frequently the communication with the calix can be seen The remainder of the pelvis is characterized by its normal appearance, and the urine from these kidneys is also normal The condition is usually discovered accidentally, or attention is called to the involved kidney by the passage of small calculi

A —This flat film of the left renal area shows a cluster of small calculi

B —An excretory pyelogram shows a normal-appearing pelvis and calices, but the calycine diverticulum is filled with opaque medium which obscures the stones This patient is a physician whom we have had the opportunity of observing frequently over a period of several years There has been no change in the appearance of the diverticulum or of the renal pelvis The only change has been diminution in the number of the calculi The patient has passed stones at various times, particularly after extended automobile rides

C —A film of the right renal area shows multiple small calculi closely grouped together

D —A retrograde pyelogram of the same patient shows filling of the diverticulum and obscuration of the calculi This patient was a man of 40 with a history of three episodes of colic, hematuria and the passage of small calculi during the preceding six months At exploratory operation, the cavity was opened and a large number of small calculi removed The kidney appeared normal otherwise, and no biopsy specimen was taken

NEPHROCALCINOSIS Nephrocalcinosis is characterized by deposition of calcium within the renal substance This usually occurs along the tubules as they pass through the papillae Although the condition is frequently found in patients with a high urinary calcium output, as with hyperparathyroidism (Albright) and prolonged immobilization, increased intake of calcium and vitamin D (Flocks), such conditions as mercury and uranium poisoning, upper intestinal obstruction and certain renal infections may also be etiologic factors Thus, its production seems to be due to (1) hypercalcinuria, (2) actual necrosis of renal tissue, or (3) conditions which allow the precipitation of calcium salts from the urine with normal calcium concentration This last form is usually due to an alkaline urinary reaction and is frequently caused by infection

A —An excretory pyelogram shows excretion from both kidneys, with extensive calcification in the papillae, apparently along the renal tubules This patient, a woman aged 46, had had painless hematuria over a period of three years There were no other symptoms The urine contained many white blood cells The patient had a chronic Bacillus coli infection with high urinary excretion of calcium, about 500 mg in 24 hours Search for hyperparathyroid disease and guinea-pig inoculations for tuberculosis gave negative results

B —A plain film of the upper urinary tract shows scattered calcifications in the renal parenchyma The bones, particularly the bony pelvis, show generalized decalcification These findings alone are sufficient to warrant a diagnosis of hyperparathyroid disease It should be borne in mind, however, that hyperparathyroid disease may be present without either renal lithiasis or bony changes The patient, a Negress of 51, had weakness and generalized pain but no urinary complaints Diagnosis of hyperparathyroid disease was substantiated by blood phosphorus, phosphatase and calcium studies An adenoma of the parathyroid was removed and confirmed by microscopic study The patient showed definite improvement following operation

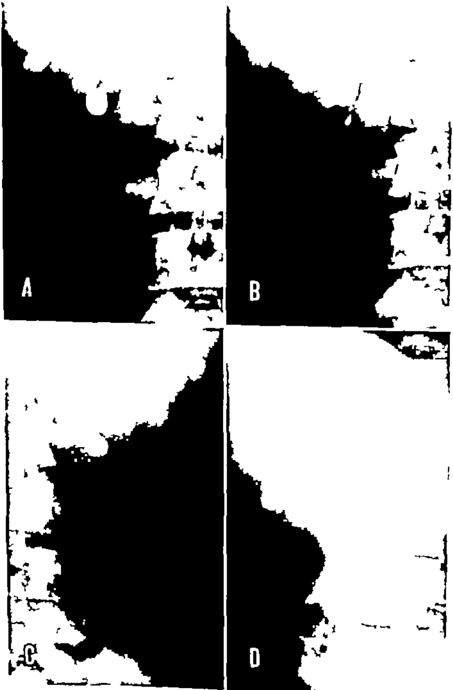
UNUSUAL STONES *A*—This radiograph is of a woman of 67, whose diagnosis was bilateral hydronephrosis and pyelonephritis with left renal calculus

B—The same calculus, seen six years later when the patient returned because of bilateral senile cataracts, had more than doubled in size In addition, other stones had formed in the upper calices Since it is necessary for a calculus to be bathed in urine in order to enlarge, this indicates that, despite extensive damage, there must have been some renal function

C—This radiograph shows the large size which a calculus may attain This stone was readily palpable through the abdominal wall It is the largest stone we have observed, weighing 570 Gm (1 256 lb) The fact that the large stone is spherical indicates, we believe, that it lay free in a hydronephrotic pelvis which allowed it to rotate and be bathed by urine on all surfaces The smaller calculi in the upper minor calices are not free to rotate, and their shape, therefore, conforms to that of the calices The patient, a farmer of 30, had enjoyed good health until 10 years before, when he had had colic requiring morphine Since then he had had recurrent attacks of pain with hematuria whenever he rode over rough ground Nephrectomy showed an aberrant vessel obstructing the ureteropelvic junction, with pyelectasis and almost complete destruction of the kidney

CYSTINE STONES These stones are rare and occur only in persons who do not metabolize cystine but excrete it in the urine Pure cystine stones are not opaque to roentgen rays

D—A large calculus fills the pelvis, with multiple round calculi in the lower pole A nephrectomy showed hydronephrosis and little renal tissue remaining The stone was composed largely of cystine, and a 24 hour specimen of urine contained 1 5 Gm of cystine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GALLSTONES SIMULATING RENAL CALCULI

Generally speaking, gallstones have a characteristic appearance. They cast annular shadows with less dense centers that are different from those of the typical dense renal calculi. Occasionally, however, the shadow of a gallstone may be difficult to differentiate from a renal stone by the appearance alone. Not only may gallstones resemble renal stones, but the converse is also true.

A.—A dense laminated calculus is located in the right upper quadrant and overlies the shadow of the kidney. The density of this stone corresponds to that seen more commonly in renal than in biliary calculi.

B.—An excretory pyelogram shows good visualization of the pelvis and calices. The shadow of the calculus is superimposed on the opaque material in the pelvis. It is observed, however, that the calices are normal. This would be most unusual with a stone of this size in the renal pelvis. Other films taken at the same time showed that the shadow of the stone did not exactly coincide with that of the pelvis. These two observations should lead one to suspect that this is a gallstone rather than a renal calculus.

C.—A postero-anterior film of the right upper quadrant shows the shadow of the calculus definitely smaller than it was in the anteroposterior view in *A* above. This indicates that the stone lies nearer the anterior than the posterior portion of the abdomen, because when an object is closer to the film there are less distortion and magnification, other factors being equal.

D.—A right lateral radiograph shows the stone lying anterior in the gallbladder area and well away from the renal area. This also proves that this is not a renal calculus. The urologic examination of this patient gave entirely negative results.


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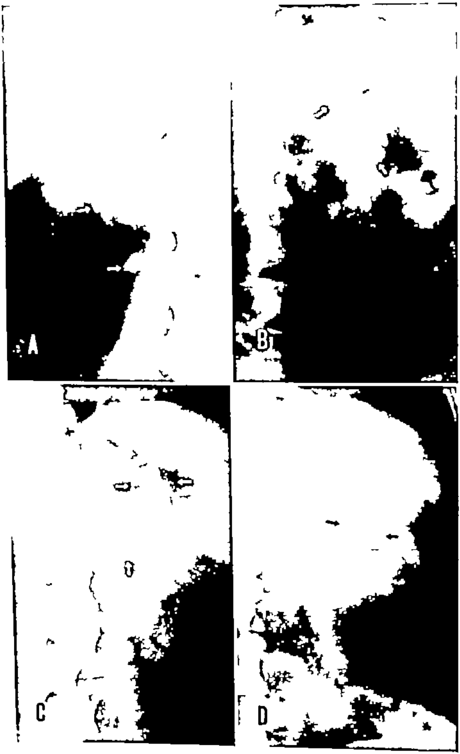
PANCREATIC CALCULI Pancreatic calculi are rare, but when they are encountered they should be recognized and differentiated from renal stones They are usually composed of calcium carbonate, which is readily visible on a radiograph The location of the shadows is an important point in diagnosis In the majority of cases pancreatic stones lie between a horizontal plane passing through the upper margin of the first lumbar vertebra and one passing through the lower margin of the third lumbar vertebra There are four types (1) by far the most common type, multiple and irregular, (2) single, (3) multiple and faceted, and (4) large fragmented stones which form a cast of the pancreatic duct The stones are most frequently found in the pancreatic duct or in the smaller ducts of the head of the pancreas which is located to the right of the vertebral column *In the differential diagnosis of pancreatic calculi, it may be necessary to visualize the renal pelvis, the gallbladder and the duodenal loop Pain is the most common* symptom, but it is variable in character and location

A —*Minute pancreatic calculi are visualized in the region of* the head of the pancreas These occurred in a woman aged 41 who complained of recurrent attacks of severe abdominal pain

B —These multiple pancreatic calculi are of the type most commonly encountered They are irregular, very dense and occupy the region of the head of the pancreas The patient, a man aged 59, also complained of pain in the abdomen The diagnosis, however, was not confirmed by operation

C —Multiple faceted pancreatic calculi are present in the pancreatic duct

D —This retrograde right pyelogram of the same patient shows the relationship of the renal pelvis to the pancreatic calculi The patient, a girl of 15, had had attacks of severe pain in the right lower quadrant since she was 3 years old The stones were removed, and analysis showed that they were composed largely of calcium carbonate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CALCIFIED RENAL AND SPLENIC ARTERIES
Calcification of these arteries may produce confusing shadows simulating tuberculosis or renal stones Optical cross-sections of the arteries produce annular shadows The calcification is usually not uniform but somewhat irregular in the wall of the vessel Any portion of the vessel may be visualized Aneurysms of the renal artery may be the result of trauma Such a lesion, however, is exceedingly rare, radiographically it appears as a more or less annular shadow which is larger than a normal renal artery and usually shows a defect on one side Calcification of the splenic artery is commonly observed in elderly people It is located in the region overlying the upper pole of the left kidney and is markedly tortuous, as is the normal splenic artery When there is calcification, a considerable portion of the artery is usually involved The serpiginous course with optical cross-sections gives an unmistakable appearance Aneurysms of the splenic artery do occur but are rare They also are characterized by calcification within the aneurysmal wall

A —Two optical cross-sections of the renal artery are observed in a woman of 73 with a nonfunctioning gallbladder The appearance was unchanged on a series of four films taken at intervals throughout the day

B —This shows typical appearance of a calcified splenic artery, seen in a woman of 73

C —This characteristic calcified splenic artery was seen in a woman of 57

D —This, we believe, is an aneurysm of the splenic artery, seen in a woman of 40 with pain in the left lower quadrant The diagnosis in this case was not confirmed by operation


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SHADOWS SIMULATING RENAL CALCULI . Extraneous shadows caused by moles on the skin and other soft tissue tumors will at times simulate those of renal calculi This is particularly true if the soft tissue tumor is in contact with the top of the table at the time of examination Such shadows are usually round, sharply circumscribed and of uniform density The density is definitely less than that of the usual renal calculus, however If serial films are obtained, as is routine with excretory pyelography, one can see that the tumor does not bear a constant relationship to the renal shadow, since any movement of the kidney due to respiration or a slight change in position of the patient causes a change in the relation of the shadow of the kidney and that of the soft tissue tumor This change of relationship of the shadows does not usually occur with intrinsic renal lesions

A —The shadow which overlies the kidney corresponds exactly to a mole on the back of the patient, a woman of 57

B —In the renal area of a patient with generalized neurofibromatosis, or Recklinghausen's disease, the shadows of several of the cutaneous tumors are observed overlying the region of the costovertebral angle

C —A defect on the intensifying screen produced a shadow simulating a renal stone These shadows are sharply circumscribed and appear on each film taken with the damaged screen In cases of doubt, it is a simple matter to examine the screen in question

D —Ossified costal cartilages are observed in the film of a woman of 31 These ossifications occur so frequently that they are scarcely worthy of mention The appearance is usually characteristic and only occasionally confusing If the course of the costal cartilages is kept in mind, the identification of these shadows is simplified

2. Bacillary infection from Bacillus coli and closely allied organisms. The acute pyelonephritis from this type of infection produces no direct radiographic signs except perhaps relaxation of the pelvis and ureter In chronic pyelonephritis of the bacillary type in which cocci are also often present there may or may not be pyelographic changes When these are present they are characteristic of the disease As Braasch has pointed out, these changes consist of ureterectasis and caliectasis. He stresses the fact that ureterectasis may be the only evidence of past or present urinary infection. This may involve the entire ureter or only a segment If the involvement is extensive there is usually some tortuosity The pelvis remains of normal size or in advanced cases may show constriction from cicatricial contractures. The calices not only are large but also show loss of the normal cupping This is due to flattening of the papillae so that the calices may be flat or even convex at their bases The sides of the calices become straight and there is narrowing of the infundibula so that the shape of the calices tends to change from conoidal to conical The narrowing of the infundibula may become complete so that the calix is closed off from the pelvis, as has been pointed out by Hyams and Kenyon The caliectasis is not uniform, as some calices may be involved and others appear to escape The dilatation is characterized by an angular and irregular appearance in contradistinction to obstructive caliectasis in which the contours are rounded and club-shaped.

[Nontuberculous Infections *continued on page 80*]

NONTUBERCULOUS INFECTIONS The problem of nontuberculous infection of the kidney is a complicated one Not only are the clinical and pathologic pictures poorly correlated, but the exact route of infection, i e, whether hematogenous, lymphogenous, ascending or by direct extension, in a given case may be open to debate That obstruction, trauma, anomalies and pre-existing disease may play a part in predisposing to infection seems established The role of the radiograph in the study of these infections is to a large extent negative rather than positive, particularly in the acute infections Certainly, in all cases of suspected infection there should be a careful correlation of clinical and urologic studies with any radiographic findings It is generally agreed that neither the renal parenchyma nor the pelvis can be involved alone, one without the other, although the infection in one may overshadow that in the other That is, a true pyelitis or nephritis does not exist, but one is always accompanied by the other, so that the term "pyelonephritis" is more appropriate Although any of the pus-producing organisms can cause pyelonephritis, a coccic or bacillary infection, or combination of the two, is most common More specifically, Staphylococcus aureus or Bacillus coli, or one of its close relatives, is most frequently found in nontuberculous infections

1 Acute staphylococcic infection of the kidney These infections are usually blood-borne from some remote focus, such as a furuncle or osteomyelitis The renal cortex is primarily involved with multiple microscopic areas of suppuration, while the pelvis is involved secondarily When multiple abscesses coalesce into a large abscess or "carbuncle" with extensive breaking down of tissue, there may be definite radiographic changes

The mass of the "carbuncle" may produce separation and deformity of the calices, or it may show communication of the abscess with the pelvis if there has been extensive parenchymal destruction Retrograde pyelograms are not advisable if this condition is suspected, and excretory pyelograms are likely to be unsatisfactory since the kidney probably will not function Acute staphylococcic infection is one of the common causes of perinephritic abscess


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CARBUNCLE *A*.—An excretory urogram shows swelling of the lower pole of the kidney and displacement of the calices by the inflammatory mass. The patient, a girl of 10, had a history of "boils" with chills and a high fever for two weeks. At operation the lower pole of the kidney was found much enlarged. When it was opened, pus and necrotic material escaped, but there seemed to be a definite line of demarcation between the involved and uninvolved portions of the kidney. Recovery was uneventful.

ACUTE PYELONEPHRITIS *B*.—This normal retrograde pyelogram showing sharp, clear-cut minor calices with no dilatation of the ureter or pelvis was made of a girl aged 19, whose diagnosis was acute pyelonephritis of three days' duration. The patient complained of tenderness in the costovertebral angle and flank. Examination showed pus in the urine and a white blood cell count of 18,000 per cu. mm. These normal pyelographic findings are to be expected, since there are usually no radiographic changes in acute pyelonephritis. Loss of the normal tone of the pelvis and ureter may occur.

CHRONIC PYELONEPHRITIS *C*.—This retrograde right pyelogram was made of a woman of 64 with a diagnosis of chronic bilateral pyelonephritis. The ureterectasis is evident, as is also the conical appearance of some of the calices, which show marked narrowing of the necks.

D.—This retrograde pyelogram was made of a woman aged 37 who was seen for the first time four years previously. In the interim the patient had been relatively free from urinary symptoms, and it was thought that the pyelonephritis had not progressed appreciably during this time. This film shows dilatation of the calices and narrowing of the infundibula but a normal-sized pelvis.

[Chronic pyelonephritis *continued on page 82*.]


A


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A —Retrograde pyelograms were made of a woman of 68 with intermittent colic in the left flank for 28 years She had passed no stones and none was seen on the plain radiograph The patient knew that she had had pus in the urine for a week and that she had had hematuria for two weeks The pyelograms show typical advanced bilateral pyelonephritis with marked caliectasis, scarring of the infundibula and ureterectasis, more advanced on the right One can see from the size of the calices that there must be extensive renal damage, with relatively little normal renal tissue

B —Retrograde pyelograms of a man of 61 with pyuria but few symptoms show marked fibrosis of the infundibula with caliectasis and ureterectasis Here, also, it is apparent that there has been a large amount of renal damage


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PYONEPHROSIS The end-stage of chronic renal infection, i e, pyelonephritis and infected hydronephrosis, is termed pyonephrosis The destroyed kidney is replaced by fibrous tissue, necrotic debris and pus Excretory urography is of little value in the diagnosis of this condition since these kidneys are usually functionless

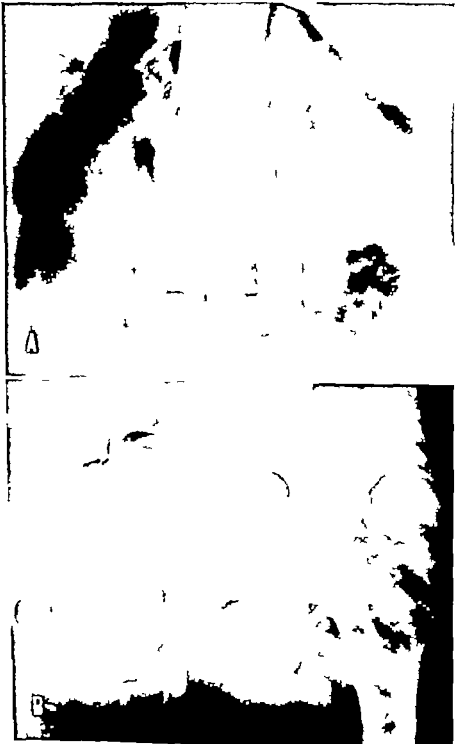
Retrograde pyelograms are characterized by the irregularity of the opaque medium and almost complete loss of all normal structures The renal outline is likely to be enlarged, and the pelvis and major and minor calices are united in a lobulated mass Differentiation between tuberculous and nontuberculous pyonephrosis is difficult The pyelogram in the former is more likely to show a "feathery" irregularity to the calices rather than no regular pattern, as seen in nontuberculous pyonephrosis Extensive neoplasm of the pelvis or renal neoplasm invading the pelvis may also closely simulate pyonephrosis

A —This retrograde left pyelogram shows loss of normal pelvic landmarks Obviously, the kidney is largely destroyed Thick, foul pus was aspirated from the pelvis through the catheter Examination for tuberculosis gave negative results

B —This pyelogram has the appearance of hydronephrosis but does show slight irregularity of outline The urine from this kidney was thick with pus Examination of the urine for tubercle bacilli gave negative results

C —There is an enlarged renal outline with large calices and the pelvis is filled with debris Stones are present in the lower pole The patient's urine had been cloudy for two years, and a specimen from the left ureteral catheter was "milky" with pus

D —This huge kidney has irregular lobulated pelvis and calices Stones were present in the kidney At nephrostomy, thick pus escaped from the renal pelvis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SPONTANEOUS GENERATION OF GAS IN AND AROUND THE URINARY TRACT The spontaneous generation of gas in the urinary tract is rare, but when it is present, the gas can readily be demonstrated on the radiograph The visualization of gas within the renal pelvis, calices, parenchyma, perirenal tissue, bladder and vesical wall has been reported It is generally agreed that the most common cause is the fermentation of dextrose in the urine and tissues of a diabetic patient with colon bacillus infection Urinary obstruction appears to be a frequent complicating factor Because of the fermentative characteristics of the colon bacillus for dextrose, the remarkable thing is that gas formation does not occur more often Cases of the formation of gas are reported, however, in nondiabetic patients and in patients with no demonstrable colon bacillus infection

A —The renal areas of a woman aged 52 with uncontrolled diabetes, colon bacillus infection and obstruction of the lower urinary tract The gas lies not only in the renal parenchyma but also in the perirenal tissue and outlines both kidneys and adrenal glands At operation, pure cultures of colon bacillus were obtained from the renal area, which was covered with bubbles of gas

B —The lower urinary tract demonstrating gas in the soft tissues From the distribution of the gas it is obvious that at least some of it is located in the muscle planes of the buttocks In this case the gas was produced by Bacillus welchii However, except for location, the appearance differs in no way from that seen with colon bacillus infection in a diabetic patient


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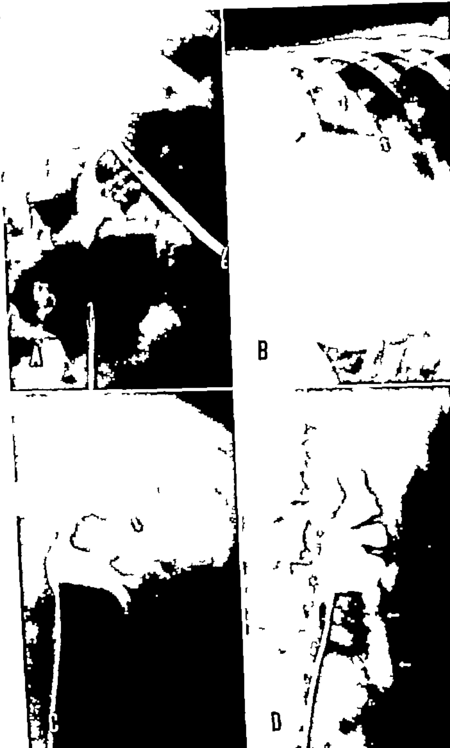
PERIRENAL ABSCESS There are several roentgenographic signs which contribute to the diagnosis of perirenal abscess, but not all of these may be present in a given instance These signs are (1) loss of the normal psoas shadow, (2) obliteration of the renal outline, (3) scoliosis of the lumbar spine with concavity on the involved side, and (4) immobility of the kidney and the diaphragm on the involved side The immobility of the kidney and diaphragm may be demonstrated fluoroscopically, or pyelographic studies made during respiration will show absence of motion on the involved side, whereas the uninvolved side will be blurred from movement Retrograde or excretory pyelographic studies may show definite deformity of the renal pelvis from pressure of a renal abscess before it has broken through the capsule, or they may show a tract communicating with the pelvis and a collection of opaque material in the perirenal space This finding is pathognomonic for perirenal abscess

A —Loss of the psoas shadow, scoliosis and pressure deformity of the lower calices The renal outline on this side is also completely obliterated A small incision was made in the renal region and ½ pt of pus was drained from the right perinephric space

B —A large renal pelvis with pressure defects characteristic of polycystic kidney In addition, there is extravasation of opaque material from the lower portion of the pelvis into the perirenal space A left perinephritic abscess was drained and about 100 cc of creamy yellow pus evacuated

C —Loss of psoas and renal outlines with extravasation of opaque medium from the pelvis On fluoroscopy the left leaf of the diaphragm was seen to be immobile A perinephritic abscess was drained

D —Tuberculous nephrocolic fistula and perirenal abscess with numerous sinus tracts At operation a shrunken, caseating kidney was found, and smears showed acid-fast bacilli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NEPHROBRONCHIAL FISTULA Pulmonary complications of acute renal and perirenal suppuration have been shown by Nesbit to be common Nephrobronchial fistula, however, is rare

A—This pyelogram shows a nephrostomy tube in the renal pelvis following drainage of a perinephritic abscess with nephrobronchial fistula.

B—This right lateral decubitus film of the chest shows the fluid level in a lung abscess which communicated with both the renal pelvis and a bronchus The patient, a woman of 28, had had pain in the left side, chills, fever, cough and sputum for three days A plain film showed a branching calculus in the upper pole of the left kidney A left perinephritic abscess was drained, but irrigation of the wound caused severe coughing Following nephrectomy, her pulmonary symptoms disappeared and there was complete recovery

PERINEPHRITIC ABSCESS FOLLOWING RUPTURE OF THE KIDNEY *C*—Retrograde pyelogram of a traumatic rupture of a kidney shows extravasation from a minor calix through the parenchyma into the perirenal space The pelvis and calices otherwise appear normal The patient was a man aged 35 who had fallen three weeks previously, striking himself in the region of the kidney Four days prior to admission aspiration of 2,000 cc of bloody urinous fluid gave great relief Two weeks later the white blood cell count and temperature became elevated A perinephritic abscess was then drained and recovery followed promptly

LEAKAGE FOLLOWING PELVIOLITHOTOMY

D—This retrograde pyelogram was made 21 days following pelviolithotomy This woman of 31 had urinary leakage through the posterior angle of the wound for the preceding five days A ureteral catheter was left in position and the wound healed promptly

any scattered calcification within a kidney which is not greatly enlarged is at least suggestive of tuberculosis and this possibility should always be considered. In tuberculosis the usual contour of the kidney is maintained, and while enlargement of the renal shadow may occur it is usually not as great as may occur with hydronephrosis, cyst or tumor

[Tuberculosis *continued on page 94*]

TUBERCULOSIS The present concept of tuberculosis of the kidney is that it is always a blood-borne infection from some focus of tuberculosis elsewhere in the body Such a focus may be in the lungs, lymph nodes, bones, gastro-intestinal tract, etc Two types of tuberculous renal infection are recognized (1) The kidney participates with other organs of the body in a generalized miliary infection Since this type of infection is practically always fatal, its significance is academic rather than clinical (2) It is now also believed that circulating tubercle bacilli may lodge in a capillary—commonly in the glomerular tuft—in the cortex of the kidney, where they may form a tubercle In this stage of the infection the lesion may heal without symptoms or it may rupture into a tubule or Bowman's space Tubercle bacilli and pus may then pass into the thin arm of the medullary loop of Henle where the organisms find more suitable soil for growth In this second or medullary location, the disease becomes of clinical importance, and usually the patient is not cured without removal of the kidney As the medullary tubercle grows, it also undergoes caseation and breaks through into the adjacent calices or pelvis Pyelograms made at this stage may demonstrate a communication between the calix and the abscess When the pelvis is involved, the scarring which ensues is likely to pinch off a calix This is recognized on a pyelogram by the absence of the calycine shadow The calices become large, irregular and ragged and have an appearance which is fairly characteristic

The pelvis likewise participates in the scarring and irregularity, but only rarely does it show dilatation The ureter early becomes involved, and this involvement is characterized by a beaded, irregular appearance, with occasional stricture formation In fact, the ureter may become completely occluded, in which instance so called autonephrectomy follows The characteristic roentgen picture when this occurs shows replacement of the renal outline by a mass of caseating tubercles 2 or 3 cm in diameter containing calcium The ureter may also take part in the calcification If the ureter does not completely close, calcification may still occur in the tubercles in the kidney Therefore,


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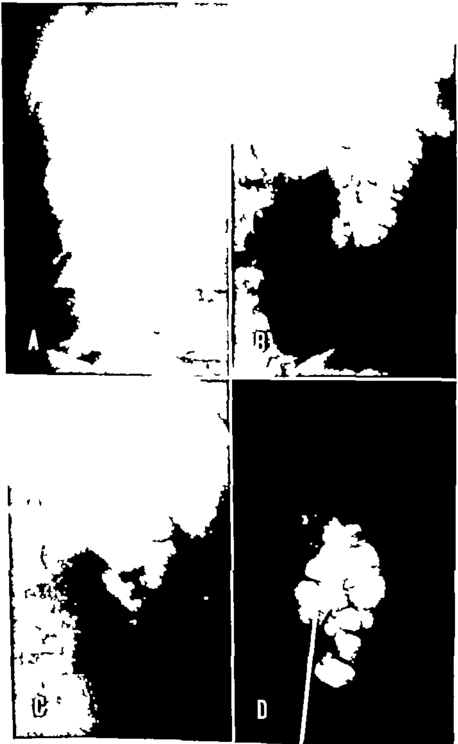
A—This pyelogram demonstrates several features of tuberculosis There is an area of calcification in the upper pole of the kidney which represents calcification in a tubercle The upper major calix has been completely pinched off The remaining visualized calices show the typical irregular, moth-eaten appearance There was gross pyuria on the left, and a smear showed tubercle bacilli

B—An abscess cavity in the upper pole of the kidney communicates with a calix There is also narrowing of the upper major calix which, however, has not been completely closed off The pelvis and the lower calices show no roentgen evidence of involvement There is some pyelotubular backflow in the lower pole The urine from the left kidney showed many pus cells and acid-fast organisms Left nephrectomy was done, and pathologic diagnosis was granuloma, probably tuberculous

C—This retrograde pyelogram demonstrates pinching off of the upper major calix The minor calices arising from this calix show the characteristic moth-eaten and irregular appearance of tuberculosis The lower portion of the pelvis does not appear involved, although there is early beading of the ureter The urine from the left kidney contained pus and acid-fast bacilli There was also growth on Corper's medium A guinea-pig was inoculated and tubercle bacilli were recovered Nephrectomy was done, and pathologic diagnosis was granuloma, probably tuberculous

D—This retrograde right pyelogram shows complete occlusion of the upper calix and some narrowing of the one below The lower portion of the pelvis and the ureter appear normal Four months previously the patient's left testicle had become swollen and indurated, and spontaneous drainage with formation of a sinus ensued The urine contained pus, but while no organisms were seen, guinea-pig inoculation was positive for tuberculosis Orchiectomy was done, and pathologic diagnosis was chronic granuloma of the epididymis, probably tuberculous

[Tuberculosis *continued on page 96*]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AUTONEPHRECTOMY, OR PUTTY KIDNEY *A*—This shows the typical appearance of the so-called autonephrectomized, or putty, kidney of tuberculosis The calcified caseating tubercles give an appearance not simulated by any other condition except perhaps a calcified tuberculous psoas abscess The patient, a man of 24, complained of frequency, burning and smarting off and on for 13 years Hematuria had been present on several occasions Cystoscopy showed edema of the bladder Clear urine could be seen coming from the left ureter, but the right ureteral orifice could not be seen because of edema The right kidney was removed There was recurrence of symptoms four years later, and at this time guinea-pig inoculation was positive for tuberculosis

B—Autonephrectomy was literally true in this man of 66 who could not recall having had any urinary symptoms The putty kidney was found incident to a gastro-intestinal examination which also showed a far-advanced carcinoma of the stomach At autopsy the diagnosis of putty kidney and carcinoma of the stomach were both confirmed

C—This typical putty kidney on the left side is almost completely replaced by calcified caseous tubercles This patient, a man of 47, gave a history of increasing frequency and urgency for 12 years He had had hematuria with some blood clots The kidney was removed

D—This radiograph of the specimen from the case in *C* distinctly shows the kidney entirely replaced by sharply circumscribed calcified tubercles It is obvious that the renal tissue had been completely destroyed and that the term "autonephrectomy" is appropriate

[Tuberculosis *continued on page 98*]


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TUBERCULOUS PYONEPHROSIS *A*.—This retrograde left pyelogram demonstrates almost complete renal destruction characterized by irregularity and areas of constriction. The patient was a woman aged 40 who complained of increasing burning, smarting and frequency for four or five years. Cystoscopic examination showed pus coming from the left ureter. The kidney was removed, and the pathologic diagnosis was tuberculosis. The patient was seen two years later because of soreness of the bladder and increasing frequency which had been relieved temporarily following the nephrectomy. The urine was again cloudy, and smears showed many pus cells and acid-fast organisms.

B.—This retrograde left pyelogram shows the appearance characteristic of renal tuberculosis, with almost complete destruction of the parenchyma, marked irregularity of the entire pelvis and great dilatation of the calices. The kidney is also definitely enlarged. The patient was a man aged 40.

C.—This retrograde pyelogram demonstrates the appearance typical of renal tuberculosis. The patient, a woman of 22, gave a history of increasing frequency for a year but had had no other urinary symptoms. The urine showed many white blood cells. The kidney was removed, and smears of the tissue showed acid-fast organisms. Cultures on Corper's medium and guinea pig inoculation were positive for tuberculosis.

D.—This pyelogram shows typical renal tuberculosis in a woman of 40 who complained of loss of weight and strength and a mass in the right side of the abdomen. Examination revealed a perinephritic abscess with nephrobronchial fistula and carcinoma of the cervix. Drainage of the perinephritic abscess was followed later by a nephrectomy. Inoculation of a guinea-pig with renal tissue was positive for acid-fast bacilli. Pathologic diagnosis was granulomatous pyelonephritis, probably tuberculous. Examination of the tissue from the cervix revealed epidermoid carcinoma.

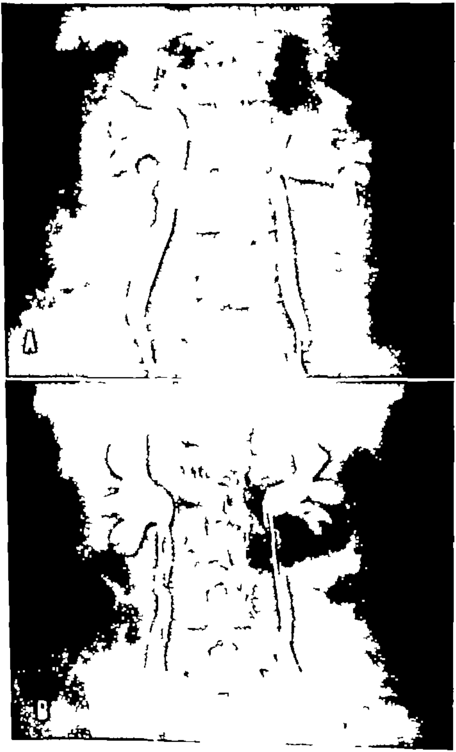
[Tuberculous pyonephrosis *continued on page 100*.]


A


B

A —Bilateral retrograde pyelograms show extensive tuberculous involvement of both kidneys On the right, there has been marked destruction of the upper pole, with irregularity of the calices in the upper and middle portions of the kidney The pelvis is fairly normal On the left, the kidney is enlarged and shows irregularity of the calices and marked scarring of the calices and pelvis The patient, a boy of 18, had had hematuria and frequency for four years and for one week had had pain in the side, burning and smarting on urination, frequency, chills and fever The urine contained much pus, and the smears were positive for tuberculosis When the ureters were catheterized, the left kidney showed no function and contained only pus, while on the right the urine was slightly turbid with pus The material from both kidneys showed tubercle bacilli The cystoscopic appearance of the bladder was also thought to be typical of tuberculosis

B —A plain film of the upper urinary tract demonstrates extensive stone formation as well as calcification within the parenchyma of the kidneys From the distribution of the calculi, it is obvious that both kidneys are greatly enlarged Twelve years before, the patient, a man of 49, had a diagnosis of bilateral renal tuberculosis on the basis of presence of acid-fast organisms in the smear He had been observed closely during the interim and he had developed bilateral pyonephrosis, bilateral renal and ureteral calculi and bilateral perinephritic abscesses which healed after surgical drainage The course was gradually downhill and he died of uremia Autopsy showed pyelonephritis with cortical abscesses, renal tuberculosis, renal and ureteral calculi and pyonephrosis, all bilateral Terminal renal insufficiency and pneumonia were the cause of death The patient had double renal pelves with separate ureters to the bladder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DILATATION DURING PREGNANCY It is well established from postmortem, retrograde and excretory urographic studies that there is a dilatation of the upper urinary tract accompanying normal pregnancy In most cases following delivery, however, there is a return to the normal state Extensive studies have been made of this problem, and it is thought that pressure on the ureters from the enlarging uterus and an endocrine effect from the pregnancy itself are the two main etiologic factors It is believed that the dilatation of the upper urinary tract predisposes to infection, although this does not necessarily ensue Following delivery, involution begins immediately and proceeds until the normal state is reached Infection appears definitely to delay normal involution

A —This retrograde pyelogram shows definite dilatation of the renal pelves The ureters are dilated, elongated and redundant The minor calices have lost some of their normal cupping, and the fornices are smooth A near-term fetus is observed in the uterus The patient, a primigravida of 13, had normal antepartum and postpartum course There was no evidence of urinary infection or other disease

B —This retrograde pyelogram is in every way similar to *A* except that the patient is but five months pregnant The patient, a primigravida of 21, had had several attacks of pain in both sides of the back with fever and chills The urine showed considerable pus, and the white blood cell count was 17,800 A diagnosis of "pyelitis of pregnancy" was made Although this patient had a definite infection, the pyelograms are indistinguishable from those of the previous patient who had no infection of the urinary tract

incomplete or intermittent The cases showing the largest hydronephroses are probably the result of intermittent obstruction Cases have been reported in which the retained fluid was measured in gallons These cases are rare at present since surgical relief is now usually obtained before the dilatation has reached this degree The pelvis and calices in hydronephrosis have smooth outlines with gently sweeping curves whereas with infection, there are likely to be irregularity and angulation with loss of the rounded contours of a true hydronephrosis

[Hydronephrosis *continued on page 106*]

HYDRONEPHROSIS Hydronephrosis is pathologic dilatation of the renal pelvis and calices with accompanying atrophy of the renal substance This results from obstruction to the flow of urine The obstruction may be located at any point along the urinary tract distal to the renal parenchyma, i e , it is possible to have obstruction of one calix with localized hydronephrosis or caliectasis The causes of hydronephrosis are as varied as the lesions that can produce obstruction to the free excretion of urine and include movable kidney with kinking of the ureter, abnormal vessels usually at the ureteropelvic junction, urinary stones, congenital contractures and valves, neoplasms, infections, operative injury, hyperplasia or neoplasm of the prostate and ureteral or urethral stricture Congenital hydronephrosis is also said to occur Much more common, however, are the congenital lesions such as aberrant blood vessels and contractures which produce obstruction and result in the development of hydronephrosis after birth In uncomplicated hydronephrosis the urine is sterile It is common, however, to have a complicating secondary infection, and this results in so called infected hydronephrosis At times, frank pus or pyonephrosis may occur The term "pyonephrosis" is reserved to refer to the end-result in a nonfunctioning kidney with the pelvis and calices filled with pus The distinction between infected and noninfected hydronephrosis in the early stages is clinical and urologic rather than roentgenologic Late in the disease, however, there are changes in the pyelogram

The roentgen changes in hydronephrosis are characterized primarily by enlargement and dilatation of the pelvis and calices In the mild type, this may be rather difficult to evaluate, since there is a certain degree of variation in the size of the normal pelvis The papillae early become flattened, and the calix loses its normal cup shape and becomes blunted or clubbed The infundibula of the minor calices become broadened, and there is relative shortening but increased size of the calices and the pelvis There is frequently a disproportion between the amount of dilatation of the calices and that of the pelvis Either may be disproportionately large Obstruction may be complete


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HYDRONEPHROSIS FROM CONGENITAL ANOMALIES, INCLUDING ABERRANT BLOOD VESSSELS Congenital anomalies definitely increase the incidence of other renal disease, since from a mechanical standpoint alone urinary drainage is likely to be interfered with This may be due either to an abnormal position of the pelvis preventing dependent drainage or to an aberrant blood vessel obstructing the ureter

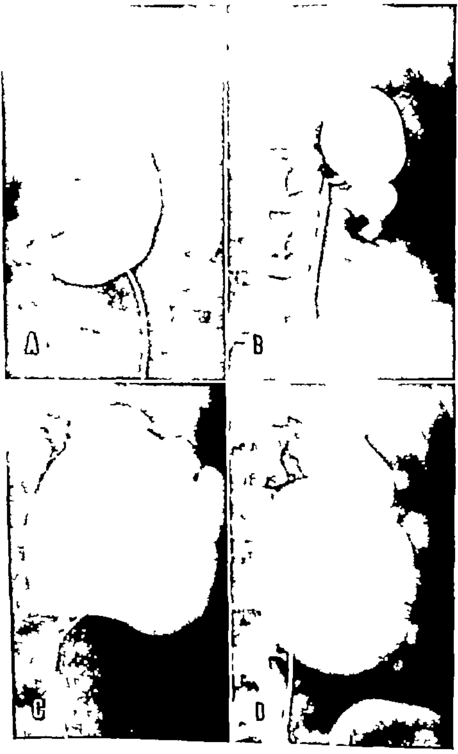
A —Crossed ectopic kidney with ureterectasis, pyelectasis and caliectasis The calices show definite clubbing The patient, a girl of 10, had, in addition, multiple congenital anomalies of the spine and legs

B —Mild hydronephrosis with definite dilatation of the pelvis The calices show some flattening of the papillae with broadening of the infundibula The patient, a woman of 55, had had pain in the back for 25 years Distention of the pelvis reproduced the pain Urine from the catheterized ureter was clear

C —Moderate hydronephrosis with dilatation of the pelvis and calices There must be considerable atrophy of renal substance, however, for the papillae are completely flattened The lower portion of the pelvis is horizontal—a common finding with mild and moderate hydronephrosis caused by obstruction from aberrant blood vessels to the lower pole of the kidney These vessels usually produce fixation of the ureter which is attached above the horizontal lower border of the dilated pelvis Left nephrectomy disclosed relatively large aberrant vessels to the lower pole of the kidney At the ureteropelvic junction was a definite stricture

D —Moderate dilatation of the pelvis with marked dilatation of the calices The calices show complete loss of papillary indentation with convex rather than concave ends (clubbing) The ureter is not visualized The patient, a girl of 18, complained only of intermittent attacks of pain in the left side for two years On removal of the kidney, several aberrant vessels were observed crossing the ureter None, however, was producing obvious obstruction

[Hydronephrosis *continued on page 108*]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A.—Dilatation of the pelvis and calices with no visualization of the ureter. The patient, a woman aged 71, complained of dull, aching pain in the back for three or four years. We consider this to represent hydronephrosis due to obstruction from an aberrant blood vessel to the lower pole of the kidney. Because of the patient's age and general condition, nephrectomy was not advised.

B.—Hydronephrotic rotated kidney with smooth, rounded contours. Because of the rotation, the high attachment of the ureter can be seen, but it appears otherwise normal. The patient, a woman of 28, complained of recurring attacks of left-sided pain for 10 years. At operation, an aberrant vessel was seen passing in front of the ureter to the lower portion of the kidney, producing obstruction at the ureteropelvic junction. A year after nephrectomy she had had complete relief of previous symptoms.

C.—Large dilated pelvis with corresponding dilatation of the calices. One can judge from this appearance that there must have been almost complete destruction of the renal substance. The patient, a youth of 20, had noticed dull, aching pain in the left flank for only six weeks. At nephrectomy, the apparent cause of the obstruction was a large vein running along the pedicle. Examination of the excised kidney showed only a thin shell of atrophic renal tissue.

D.—Marked dilatation of the pelvis and calices. The pelvis is spherical and obviously overhangs a highly attached ureter. The calices show definite clubbing, and the findings indicate destruction of the renal substance. The patient, a woman aged 32, had had recurrent pain on this side for 15 years. Enormous hydronephrosis, with little renal substance, was found at operation. An aberrant vessel extended across the pelvis and fixed the ureter at the ureteropelvic junction.

[Hydronephrosis *continued on page 110*.]


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A.—Horseshoe kidney with large hydronephrosis on the left. The calices are medial and the ureter is lateral. The patient, a boy of 11, had had no symptoms until two days before, when he had pain and hematuria. Plain films showed a calculus in the left pelvis. At nephrectomy the pelvis was anterior, aberrant vessels were obstructing the ureter, and a bridge of renal tissue extended across the midline between the lower poles.

HYDRONEPHROSIS FROM OBSTRUCTION OF THE LOWER URETER. Obstructions in the lower ureter result in dilatation of the ureter, pelvis and calices, but as a rule the pelvis does not take part in the dilatation to such a marked degree as it does with obstruction at the ureteropelvic junction.

B.—Moderate hydronephrosis with long, dilated ureter. The patient, a woman aged 58, had had right renal colic four days before admission. Three small stones were found at the ureterovesical junction. These were extracted.

C.—Right hydronephrosis and hydro-ureter, with definite lengthening of the ureter. The patient, a man of 38, had an impacted stone in the lower end of the ureter demonstrated on a film two months before. At that time he had attacks of severe colic but had had none previously.

D.—Retrograde pyelogram showing dilatation of the pelvis, calices and ureter, with elongation and coiling of the ureter. Here, also, the pelvis does not show the marked dilatation observed with obstruction at the ureteropelvic junction. The patient, a woman aged 37, for three months had had recurring attacks of pain in the right flank severe enough to require morphine. Roentgenograms had shown a stone in the lower end of the ureter for the previous six months. Examination of the urine from the right kidney showed infection but no frank pus.

it has no direct relation to the size of the tumor since it occurs in small as well as large neoplasms

In retrograde pyelography a tumor is revealed by distortion of the pelvis and calices and visualization of a mass with or without calcification

The deformities of the pelvis and calices due to tumor vary greatly in appearance. As the tumor expands, it tends to become spherical and thus elongates the nearest major calix or calices and perhaps even the pelvis Pressure from the tumor may also cause narrowing of portions of the major and minor calices that are close to it. If the tumor lies between two or more calices they will of course, be separated. There is no predilection for either kidney or for the location of the tumor in the kidney At times nearly the entire kidney appears to be diffusely involved by the tumor and thus produces elongation compression and separation of all the calices and compression of the pelvis This is the so-called spider leg deformity Usually however the mass is located in such a position that only a portion of the pelvis and one or two major and adjacent minor calices become distorted. Some tumors may invade the pelvis and at times the normal landmarks are completely obliterated by tumor debris and blood clots in the pelvis and calices. In this event it may be impossible to differentiate a tumor of the parenchyma which invades the pelvis from a primary tumor of the pelvis which has secondarily invaded the renal substance In general however tumors of the pelvis do not distort the renal outline whereas primary tumors of the renal parenchyma are prone to do so Occasionally definite hydronephrosis accompanies a renal tumor Whether this was pre-existing or was the result of obstruction from pressure of the tumor in a given case may be open to question In either event, there are usually elongation and compression of the pelvis or calices that cannot be accounted for by the hydronephrosis alone

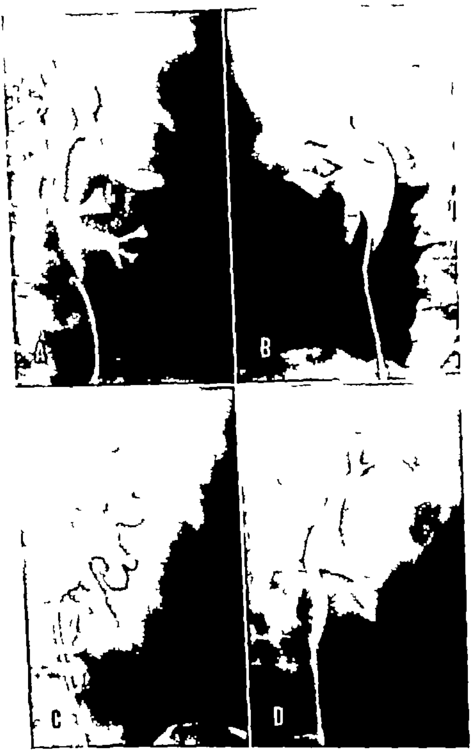
[Malignant tumors *continued on page 114*]

MALIGNANT TUMORS IN ADULTS The classification of these tumors has long been a controversial subject. No general agreement has been reached, particularly regarding tumors arising in the renal parenchyma. Whether they arise entirely from renal tissue (*renal cell carcinoma*) or whether some of them arise from adrenal rests (hypernephroma) is more of an academic than a practical question at this time.

From the standpoint of roentgen and clinical diagnosis, tumors of the kidneys in adults fall into two main groups: (1) those arising in the renal parenchyma, and (2) those arising in the pelvis. Until clinical and roentgen differentiation can be made beyond this point, we think that further discussion of the pathology is not warranted in a book of this type.

MALIGNANT TUMORS ARISING IN THE RENAL PARENCHYMA In our experience these tumors comprise about 90 per cent of the primary tumors of the kidney in adults. The incidence in men is about three times that in women. Two thirds of these tumors occur in the fifth and sixth decades, and it is exceedingly rare to find a primary tumor of the kidney in an adult under 30.

The roentgen examination of patients suspected of having renal tumors should include both plain films of the urinary tract and retrograde pyelograms. Lateral pyelograms are at times of assistance and may clearly show a deformity of the pelvis or calices which is not well shown in views taken in the anteroposterior projection. On the whole, excretory pyelograms are inadequate, since the pelvis of a kidney involved by a neoplasm is likely to be unsatisfactorily visualized. Primary tumors of the parenchyma usually distort the renal outlines. This point is of great importance and should always be looked for. At least one third of the renal tumors show calcification which is discernible in radiographs of good quality. These calcic deposits usually appear as diffuse amorphous flecks in the central portion of the tumor, although occasionally plaques of calcium 1–2 cm in diameter are present. *While calcification in the tumor is probably* related to the loss of blood supply with resulting necrosis,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A—This large tumor of the upper pole causes distortion of the renal outline The upper major calix is elongated and narrowed The upper minor calices are stretched around the mass, show a pressure deformity and have entirely lost their normal configuration Nephrectomy was done, and pathologic diagnosis was "hypernephroma"

B—The lower minor calices are largely obliterated by pressure from a mass in the lower pole of the kidney The partially visualized calices are elongated, distorted and compressed around the expanding mass The kidney was removed, and pathologic diagnosis was "hypernephroma"

C—The lower pole of the kidney is enlarged by a tumor containing flecks of calcium In this instance the pelvis is small, and while there is separation of the major calices, the evidence of compression is slight but definite The upper end of the ureter is displaced medially and the kidney rotated in a clockwise direction Large areas of necrosis with calcification were found in the specimen Pathologic diagnosis was "hypernephroma"

D—This is a classic example of a pyelogram showing the deformity of renal tumor The upper and lower major calices are separated and show pressure defects from the expanding mass Elongation and narrowing of the upper major calix are also well demonstrated From the separation of the calices, it is obvious that the kidney is larger than normal Nephrectomy was done, and pathologic diagnosis was "hypernephroma" of the upper pole of the kidney

[Malignant tumors *continued on page 116*]


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A —Loss of renal outline, with elongation and narrowing of the major calices When the kidney is uniformly involved and the tumor is not limited to one pole, the so called spider-leg deformity results This is characteristic of primary renal tumor This patient's only symptom was hematuria Nephrectomy was done, and pathologic diagnosis was "hypernephroma "

B —Huge kidney with great elongation of the major calices The opaque medium has extravasated into soft, friable neoplastic tissue at the upper pole The appearance is typical of the spider-leg deformity of renal tumor Examination showed a huge mass filling the left half of the abdomen Nephrectomy was done, and pathologic diagnosis was "hypernephroma "

C —Large mass in the upper pole of the kidney, with diffuse flecks of calcium on the original film The pelvis and calices are greatly elongated and follow the curve of the expanding tumor In this instance, the major calices are pushed together rather than separated, as occurs most commonly The kidney was removed, and pathologic diagnosis was embryonal adenocarcinoma

D —Huge kidney with distortion of all of the components of the pelvis and calices Both major and minor calices show elongation, wide separation and pressure defects—the so-called spider-leg deformity There is localized dilatation of the extreme upper minor calices from obstruction of the upper major calix The ureter is displaced medially On removal, the kidney was found diffusely involved by neoplasm Only a small amount of renal tissue remained in the specimen Pathologic diagnosis was "hypernephroma "

[Malignant tumors *continued on page 118*]


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A —Pyelogram showing large dilated pelvis and calices The lower calices are somewhat elongated, but it is doubtful if renal neoplasm could be diagnosed from the pyelogram alone In fact, the patient had no symptoms referable to the kidney until he fell and injured his back five weeks before death Gross hematuria and pain had followed the injury At autopsy, a massive hemorrhage into the kidney was found, which accounted for much of its enlargement Pathologic diagnosis was adenocarcinoma

B —Large kidney showing evidence of marked pressure on the pelvis and calices from an expanding mass A well defined ring of calcification is seen Others are present in both upper and lower poles but are partially obscured by overlying calices The removed kidney showed a large tumor with little normal renal tissue Pathologic diagnosis was "hypernephroma"

C —Pyelogram showing a large hydronephrotic pelvis with a large, smooth filling defect The ureter is attached high and is not greatly dilated One would suspect hydronephrosis due to obstruction of the ureter from an aberrant blood vessel to the lower pole of the kidney This was, in fact, found at operation and, in addition, a tumor of the upper pole with extension into the pelvis Pathologic diagnosis was "hypernephroma"

D —Pyelogram showing complete loss of normal landmarks which are replaced by infiltrating neoplasm The kidney is large, and its outline is rendered indistinct by capsular infiltration The same appearance can be produced by primary tumor of the renal pelvis invading the parenchyma Autopsy revealed extensive metastases and the kidney replaced by neoplasm Pathologic diagnosis was "hypernephroma"

[Malignant tumors *continued on page 120*]


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A.—Definitely enlarged kidney. The pelvis and calices show a large pressure defect without the elongation commonly seen. The appearance, however, is typical of one manifestation of primary renal tumor. The patient, a man of 62, complained of marked loss of weight and general malaise. Physical examination showed a tumor in the left upper quadrant. There had been no urinary symptoms or hematuria. Nephrectomy was done, and pathologic diagnosis was "hypernephroma."

B.—Enlarged lower pole of the kidney, with elongation and narrowing of the major calices around a mass. Several calices show caliectasis. The patient, a man of 57, had had hematuria two years before but none since. Recently he became weak and unable to work and lost weight. A left nephrectomy was done, and pathologic diagnosis was "hypernephroma."

BONY METASTASIS FROM "HYPERNEPHROMA"

Primary tumors of the renal parenchyma commonly metastasize to bone, and occasionally the first symptoms are from metastasis. The metastatic bony lesions are always osteolytic, with extensive destruction of bone but little, if any, osseous reaction. The secondary lesions cannot in themselves be differentiated from osteolytic metastasis from other neoplasms.

C.—Pathologic fracture with extensive bony destruction in the region of the nutrient artery of the femur. This appearance is to be expected with "hypernephroma" metastatic to bone but can also be produced by other secondary neoplasms. The patient, a woman of 48, entered because of the fractured femur. Pyelograms showed a "hypernephroma" deformity of the kidney.

D.—Extensive destruction of the pubis and ischium with no bony reaction. This appearance is to be expected with, but is not pathognomonic for, "hypernephroma" metastatic to bone. The patient, a man of 71, had had pain in the left hip and leg for one year. Except for one episode of hematuria two years before, there had been no urinary symptoms. At autopsy, a primary tumor of the renal parenchyma with bony metastasis was found.

[Malignant tumors *continued on page 122*.]

metastasize extensively The pyelogram shows an amorphous collection of opaque medium with complete loss of normal structures. The appearance is indistinguishable from that produced by some tumors arising in the parenchyma and invading the pelvis As a group however many cases are associated with stones in the pelvis It is believed that the irritation of the stones in some instances leads to metaplasia of the pelvic epithelium with formation of tumor since some of these neoplasms are well differentiated squamous cell carcinomas with epithelial pearls. The prognosis for nonpapillary tumors is poor but fortunately they are rare.

[Malignant tumors *continued on page 1 4*]

TUMORS OF THE RENAL PELVIS About 10 per cent of the renal tumors in adults arise from the pelvis These are either papillary or flat infiltrative growths

The degree of malignancy of papillary tumors varies greatly All tend to recur after removal Many are prone to establish implants along the ureter or in the bladder or, as some believe, to develop in multiple locations Others metastasize to bone or lungs and thus reveal their true nature A malignant papillary tumor without metastasis cannot be differentiated by radiographic studies from a relatively benign papilloma

Hematuria is usually the first symptom of papillary tumors and is almost always present at some time before a physician is consulted The passage of blood clots is common and is usually accompanied by colic Rarely, the first symptom may be from metastasis to bone, lungs or brain Usually a mass cannot be palpated

On retrograde pyelograms a small papillary tumor produces an irregular mottled filling defect without distorting the uninvolved portion of the pelvis or the renal outline Filling defects due to blood clots tend to be smooth in outline rather than irregular, as is the case with papillary tumors Also, defects from blood clots can usually be made to disappear wholly or at least partially by repeated washing of the pelvis

With larger papillary tumors, the pelvis may be almost completely filled with neoplastic tissue Tumors of this size distort the pelvis and may obstruct some of the calices, with resultant localized hydronephrosis Even though the pelvis is nearly filled with tumor, the outline of the kidney is not distorted

The ureter is a frequent site of implants and may be completely blocked by tumor so that a pyelogram cannot be obtained A patient suspected of having a papillary tumor of the renal pelvis should have a careful examination of the bladder for secondary implants, since these occur in a high percentage of such cases

Flat nonpapillary tumors not only may invade and distort the renal pelvis, but may infiltrate the parenchyma and produce enlargement of the renal outline These are highly malignant and


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A.—An irregular filling defect is seen in the outer portion of the pelvis. This extends into the middle and lower major calices but does not block them completely. The mottled papillary character is apparent. There is no distortion of the renal outline. Following removal of the kidney, a papillary growth was found corresponding to the filling defect in the pyelogram. Pathologic diagnosis was papillary transitional cell carcinoma of the renal pelvis.

B.—This is a typical papillary defect in lower major and minor calices, with but little distortion of the calycine outline and no deformity of the kidney. The patient, a Mexican woman of 31, had had intermittent hematuria for one year. A nephrectomy disclosed a papillary tumor filling the lower calix. Pathologic diagnosis was papilloma.

C.—This pyelogram shows a sharply circumscribed defect in the upper half of the pelvis and only the lower half visualized, but the kidney is of normal size. The patient, a man aged 42, had had intermittent hematuria with passage of wormlike clots for eight months. Lifting would sometimes initiate bleeding. Examination of the excised kidney showed the upper calix covered by a flat papillomatous lesion which all but obstructed it. Pathologically, the epithelium of the calix was overgrown, and beneath the mucosa were strands and clumps of well differentiated carcinoma cells. Pathologic diagnosis was transitional cell carcinoma of the renal pelvis.

D.—This pyelogram shows obliteration of all except the upper calix. The renal pelvis is encroached on, yet the remaining border is not distorted. The renal outline is obscured by gas in the intestines. The patient, a man of 67, had had no symptoms except hematuria once a week for three months. Nephrectomy was done, and pathologic diagnosis was transitional cell carcinoma of the renal pelvis. He died four months later, and at autopsy generalized carcinomatosis was found.

[Malignant tumors *continued on page 126*.]


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A—This retrograde pyelogram demonstrates a small filling defect in the upper major calix The man, 75 years old, had noted gross hematuria for six months For two months he had had aching pain in the upper right thigh and upper left humerus Cystoscopy showed a small, pale papillary tumor of the bladder This was resected, and pathologic diagnosis was papillary carcinoma

B—The right femur of the same patient shows a lesion which we believe to be metastasis from the kidney The bony findings are in no way characteristic of a metastatic neoplasm of the renal pelvis Pathologic diagnosis of a biopsy specimen was metastatic carcinoma

C—In this pyelogram the papillary character is not quite so obvious, since it is overshadowed by the smooth filling defects in the pelvis and ureteropelvic junction due to blood clot The lateral midportion of the pelvis does show characteristic mottling, however The upper major calix is partially occluded, with resultant localized dilatation Here, also, there is no distortion of the renal outline Nephrectomy was done, and pathologic diagnosis was papillary carcinoma of the renal pelvis Six months later the patient returned with a papillary tumor of the bladder

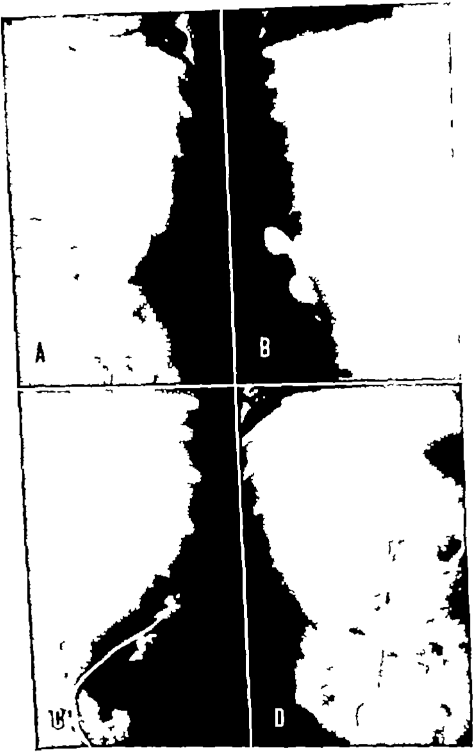
D—This pyelogram shows a conglomerate collection of opaque material and complete loss of normal landmarks The renal outline appears enlarged The appearance suggests either tumor of the pelvis invading renal tissue or primary tumor of the parenchyma invading the pelvis Pyonephrosis could also simulate this appearance Nephrectomy was done, and pathologic diagnosis was chronic pyelonephritis with squamous metaplasia and epidermoid carcinoma

[Malignant tumors *continued on page 129*]

MALIGNANT TUMORS IN CHILDREN Since the clinical diagnosis of malignant neoplasms of the kidney and renal region in children is fairly definite the role of roentgenographic studies is chiefly confirmatory A painless mass in the upper abdomen of a child under 7 is prima facie evidence of an embryoma of the kidney or neuroblastoma of the adrenal Roentgenographically it is impossible to differentiate between them. The plain film always shows a large, soft tissue mass in the upper quadrant Pyelographic studies may help to determine the point of origin by indicating whether the kidney is merely displaced or actually invaded Invasion suggests the kidney as the site of origin but an extrarenal neoplasm may involve the kidney secondarily With a neuroblastoma arising in the adrenal the kidney is less likely to be invaded and is more often displaced downward. Although they usually occur high up embryomas may arise in any portion of the kidney or retroperitoneally along the course of the renal anlage When the tumor originates in the kidney the organ is displaced usually down and lateral and the pelvis and calices are separated or distorted. When the lesion originates extrarenally however practically the only findings are displacement and distortion from external pressure With retroperitoneal tumor the displacement is down anterior and lateral and the pelvis is compressed by the mass Hematuria and pain are not common Bilateral tumors occur but are rare There is no predilection for either sex or side From a practical point of view there is little to be gained from making a differential diagnosis between neuroblastoma and Wilms tumor because the prognosis for both is poor

Polycystic disease in children is rare especially that involving one kidney In the one such case that we have encountered the pelvic and calyceal distortion could not be distinguished from that produced by a primary renal tumor

[Malignant tumors *continued on page 130*]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A—Excretory left urogram of a boy of 2, showing a large upper quadrant soft tissue tumor which displaces the kidney down to the crest of the ilium The renal pelvis is not seen as such, and the calices are distorted Nine days before admission the parents had noted an abdominal mass There had been no hematuria or other urinary symptoms Following irradiation there was rapid decrease in size of the mass, and about seven weeks later the kidney with part of the remaining mass was removed Pathologically, the kidney was not invaded, and the lesion did not appear to have arisen from the adrenal It was therefore thought to have originated retroperitoneally from the renal anlage as an undifferentiated malignant neoplasm—Wilms' tumor

B—Retrograde right pyelogram showing downward and lateral displacement of the kidney, with loss of the upper calycine shadow and slight hydronephrosis The soft tissue mass can be distinctly seen A film of the chest showed pulmonary metastases The patient, a girl of 4, had had gradual increase in the size of the abdomen for one month The only other finding was engorgement of the superficial abdominal veins which indicated vena caval obstruction The mass was irradiated without appreciable effect

C—Retrograde left pyelogram showing an upper quadrant mass which displaces the kidney downward and lateral Aside from evidence of compression, the kidney appears relatively normal Following irradiation, the mass practically disappeared, but since there was evidence of distant metastasis, no surgical measures were undertaken

D—Retrograde right pyelogram showing medial displacement of the kidney and gross distortion of the pelvis and calices, which also appear somewhat dilated Diagnosis was Wilms' tumor and irradiation given Because there was no decrease in size of the mass, surgery was advised The mass was removed at another clinic Pathologic diagnosis was polycystic kidney


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BLOOD CLOTS IN THE PELVIS AND CALICES

A blood clot in the renal pelvis or calices displaces the opaque medium of a pyelogram, but sufficient medium usually remains to outline faintly the area containing the clot Blood clots in the pelvis appear as somewhat elongated, ovoid and sharply bordered defects in the contrast substances In the calix, however, where they are more frequently seen, clots appear as slightly shrunken calyceine casts surrounded by opaque medium This may well be due to a combination of shrinkage of the clot and distention of the calix by the pressure of the injection All blood clots must be differentiated from (1) nonopaque stones, (2) primary tumors of the renal pelvis and (3) primary parenchymal tumors with invasion of the pelvis

A —A retrograde pyelogram made following hematuria shows filling defects from blood clots in the upper calix One month later the patient died of a cerebral hemorrhage At autopsy, the renal pelvis on the right was perfectly normal except for a slight hemorrhagic area in the pelvic mucosal layer

B —This excretory pyelogram shows the typical defect from a blood clot Cystoscopic examination showed bloody urine coming from the left ureter A retrograde pyelogram made at a later date was normal, however

C —This retrograde pyelogram shows a deformity typical of renal tumor In addition, there are smooth filling defects in the pelvis and lower calices having the appearance characteristic of blood clots A pyelogram taken one month later, at a time when there was no hematuria, showed only the deformity of the tumor and absence of the blood clots Nephrectomy was done, and pathologic diagnosis was "hypernephroma"

D —This pyelogram, made after hematuria, shows typical blood clot in the lower calix A progress pyelogram made three years later was normal


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CALCIFICATION OF THE ADRENAL GLANDS
Calcification of the adrenal glands is occasionally encountered in roentgen examinations of the urinary tract. It is generally considered to be due to tuberculosis of the adrenals with associated Addison's disease. However, we have more often discovered calcification of the adrenals as an incidental finding without other evidence of either tuberculosis or Addison's disease. The condition is recognized by its location in the adrenal area and, when there is sufficient calcification, by the characteristic shape.

A.—Calcification in the left adrenal. The finding was incidental to an examination of the urinary tract. There were no signs or symptoms of hypo-adrenalism. The urine was examined for acid-fast organisms and found negative. Cultures on Corper's medium and guinea-pig inoculations were also negative.

B.—Calcifications within both adrenal areas. The patient, a boy of 12, was seen because of pain in the abdomen. There were no findings to suggest adrenal disease, and three tuberculin tests were negative.

TUMORS OF THE ADRENAL GLAND. The adrenal gland can be delineated by the injection of a gas into the perirenal space. This outlines both the renal and the adrenal area.

C.—A normal kidney and adrenal outlined by the injection of oxygen. The patient was a girl aged 19 with increased growth of hair on the face and forearms. No adrenal tumor was found on either side.

D.—A perirenal oxygen injection outlining the kidney and adrenal gland. The adrenal is definitely larger than normal, and the plain film shows flecks of calcification within it. The patient, a woman of 34, had blood pressure of 250/150; following removal of the adrenal tumor, it fell to 135/95. Pathologic diagnosis was paraganglioma (pheochromocytoma in adrenal).

The Ureter

THE NORMAL URETER From the renal pelves the ureters pass downward and medially, over or near the tips of the transverse processes of the lumbar vertebrae, swing slightly outward over the sacro-iliac joints to enter the bony pelvis From here they follow the curve of its wall, first outward and downward, then inward, and downward to enter the bladder

Because of peristaltic waves, the normal ureter is rarely visualized in its entirety on excretory urograms If it is distended, however, the ureter may occasionally be visualized throughout its entire length on retrograde ureterograms Even then it shows varying diameters due to peristalsis so that its walls are not parallel as shown in texts on anatomy Three points of narrowing of the ureter are recognized anatomically (1) at the ureteropelvic junction, (2) where the ureter crosses the iliac vessels, and (3) at the ureterovesical junction

A —Retrograde ureterograms of a woman of 29, showing normal ureters

B —Retrograde ureterograms of a girl of 19, showing the usual wavy appearance of normal ureters

PERFORATION Occasionally, particularly in the presence of a stone or stricture, the ureter is perforated during an attempt to pass a catheter Injected opaque medium then infiltrates the soft tissues around the ureter

C —The tip of the catheter has perforated the ureter at the site of an apparent stricture A small amount of injected skiodan has diffused around the ureter This patient had a ureteral stone at a higher level, but none could be seen radiographically at the site of perforation

D —There is extravasation of a large amount of opaque material in the periureteral tissues on the right During an attempt to pass a catheter by a stone in the right ureter, the ureter was perforated, and injection of opaque material showed extravasation around the ureter rather than the expected ureterogram


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CONGENITAL ANOMALIES The commonest congenital anomaly of the ureter is bifurcation This may occur at any level In its mildest form it consists of a bifid pelvis, but the ureters may unite at any level between the renal pelvis and the bladder or may enter the bladder separately When entering the bladder separately the opening of the ureter leading to the upper pelvis is almost always distal to the orifice of the ureter from the lower pelvis Occasionally, one ureter empties into the bladder in normal position, while the anomalous ureter empties into the urethra or vagina

A —This retrograde pyelogram shows double renal pelvis with ureters joined at a high level

B —A film taken of the right ureteral area following excretory urography demonstrates reduplication of the upper half of the ureter on the right These unite at the level of the upper border of the sacrum and extend as a single ureter to the bladder The patient was a woman of 31, with pain in the right upper quadrant Pyelographic findings on the right were normal otherwise

C —This excretory urogram shows separate ureters which join a short distance above the bladder In the ureter from the lower pelvis is a calculus just above the point of juncture

D —An anomalous ureter on the right opens into the urethra There are opaque catheters in the ureters on both sides Opaque medium has been injected in the anomalous ureter and the urethra, whereas the bladder has been outlined by injection of air The patient, a Negress of 20, had no urinary complaints and had never been incontinent Retrograde pyelograms showed the ectopic ureter leading to a vestigial club-shaped nonfunctioning pelvis in the upper pole of the kidney The lower renal pelvis and calices had good function and were normal

it is advisable to have ureterograms as well and if the shadow in question produces either a filling defect in or is completely obscured by the opaque medium in both views, it must certainly lie within the ureter It must be borne in mind that ureteral calculi do not necessarily remain in one position but are likely to pass down the urinary tract. They are particularly likely to change position during and following anesthesia and instrumentation. In fact they may be displaced up the urinary tract during the passage of a ureteral catheter or attempted extraction. For this reason it is often advisable to obtain films immediately before operative procedures to ascertain if change of position has occurred. Not only is this in the best interest of the patient, but it may save the embarrassing situation of searching for a stone that is not present

There are many normal and abnormal findings that may simulate ureteral calculi Phleboliths calcified lymph nodes the tip of a transverse process of a lumbar vertebra fecaliths in the appendix, film artefacts, vascular plaques and teeth or bone in dermoid cysts account for the more common shadows that may be confused with ureteral calculi

[Calculi *continued on page 144*]

CALCULI Ureteral calculi are usually stones that have formed in the kidney and become lodged in the ureter On rare occasions, however, they may be formed entirely within the ureter, or, if formed in the kidney and lodged in the ureter, they may grow by the accretion of salts deposited from the urine They may occur in any location between the renal pelvis and the bladder The most common sites, however, are the three points of anatomic narrowing (1) the ureteropelvic junction, (2) where the ureter crosses the iliac vessels, and (3) the ureterovesical junction The size of the ureter to some extent determines the size and shape of the calculus that can be passed into it from the kidney, so that a stone greater than 0 5 cm in diameter will not be found in a normal ureter However, in cases of obstruction with dilatation of the ureter, stones of unusual size may occur These may show laminations indicating the deposition of calcium salts on the stones while in the ureter These stones may measure 2—3 cm in diameter and may be several centimeters long, or they may be multiple and faceted Most ureteral calculi, however, are oval, with the long axis of the stone corresponding to the long axis of the ureter Stones which have passed into the ureter from the kidney are usually slightly irregular and do not have the smooth outline of stones which have formed within the ureter Ureteral stones, like renal calculi, are usually opaque because of the calcium content, although nonopaque stones do rarely occur When diagnosing ureteral calculi, one must first ascertain that a suspected shadow lies along the course of the ureter, and although it can be strongly suspected from the flat film, it is usually necessary to visualize the ureter to make a positive diagnosis The most common method is to place an opaque catheter in the ureter and obtain stereoscopic or, better still, anteroposterior and oblique radio graphs With but two exceptions, the shadow of a ureteral cal culus will lie in contact with the catheter in both anteroposte rior and oblique views The catheter may be separated from the stone (1) when the stone is small and the ureter large, or (2) when, in rare instances, a true ureteral calculus ulcerates through the ureter and lies outside it When possible, therefore,

it is advisable to have ureterograms as well and if the shadow in question produces either a filling defect in or is completely obscured by the opaque medium in both views, it must certainly lie within the ureter It must be borne in mind that ureteral calculi do not necessarily remain in one position but are likely to pass down the urinary tract. They are particularly likely to change position during and following anesthesia and instrumentation. In fact they may be displaced up the urinary tract during the passage of a ureteral catheter or attempted extraction For this reason it is often advisable to obtain films immediately before operative procedures to ascertain if change of position has occurred. Not only is this in the best interest of the patient, but it may save the embarrassing situation of searching for a stone that is not present.

There are many normal and abnormal findings that may simulate ureteral calculi. Phleboliths calcified lymph nodes the tip of a transverse process of a lumbar vertebra fecaliths in the appendix film artefacts vascular plaques and teeth or bone in dermoid cysts account for the more common shadows that may be confused with ureteral calculi

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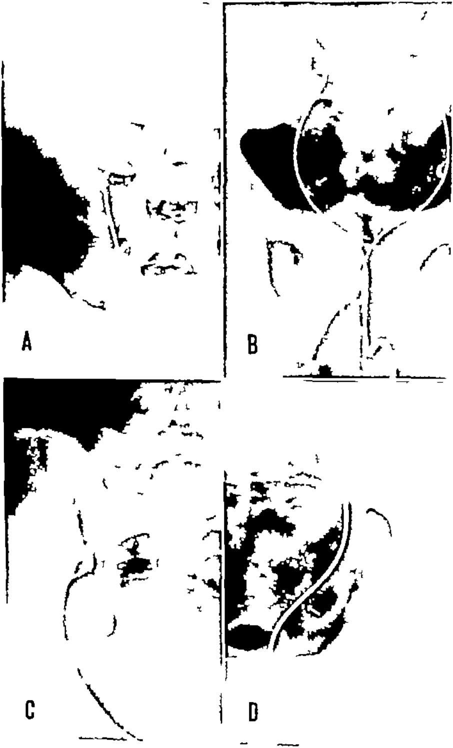
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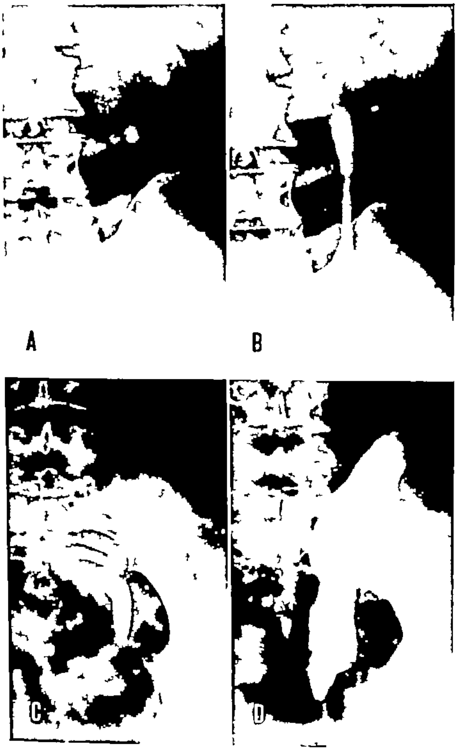
A.—A film of the urinary tract shows an opaque catheter in the right ureter. The tip of the catheter is in contact with a small shadow of increased density having the appearance of a ureteral stone. Since it was thought that a stone this small would eventually pass, no treatment was advised.

B.—This anteroposterior film of the lower urinary tract shows a catheter in contact with an oval and slightly irregular shadow in the region of the ureteropelvic junction, indicated by the arrow. It would be necessary to obtain an oblique view or a ureterogram before positively identifying this shadow. A right ureterolithotomy disclosed a stone firmly lodged in the ureter at the ureterovesical junction.

C.—A film of the lower urinary tract shows an oval shadow of calcium density in the region of the ureterovesical junction with its long axis paralleling that of the ureter. The outline is smooth, suggesting that if the stone was not formed in the ureter, it at least had been in this location for some time and had acquired calcium salts. Cystoscopy showed a stone bulging from the right ureteral orifice. The stone was later extracted, and analysis showed it to be composed mainly of calcium oxalate with some calcium prosphate.

D.—A film of the lower urinary tract shows an opaque catheter in the left ureter. The catheter appears to lie in contact with a small shadow of calcium density, apparently a stone, in the region of the ureterovesical junction. There are other shadows of similar size and appearance which are not in contact with the catheter and are presumably phleboliths. The pyelogram on this side showed mild hydronephrosis and hydro-ureter. A portion of the stone was extracted and the remainder passed spontaneously seven days later.

[Calculi *continued on page 146*.]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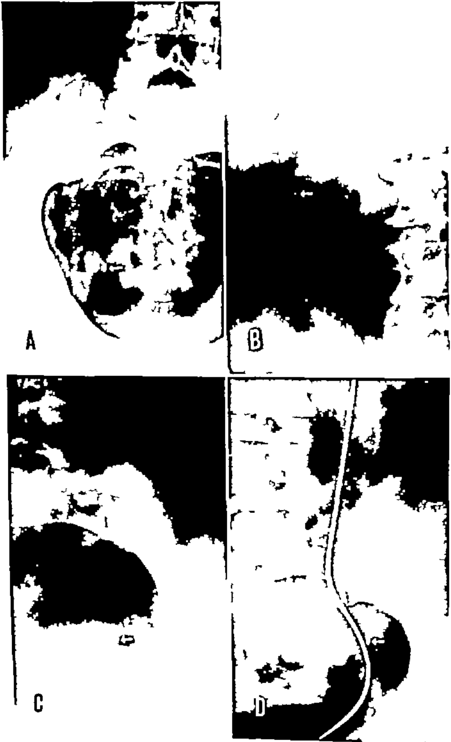
A.—A flat film of the urinary tract demonstrates a small calculus in the lower pole of the left kidney. In addition, there is a slightly irregular oval shadow of uniform calcium density in the upper end of the ureter.

B.—A ureterogram shows the same stone as a filling defect at the level of the transverse process of the fourth lumbar vertebra. The ureter immediately below appears constricted. This patient, a man of 37, had a coral or branching calculus removed from the left kidney three months previously. After what appeared to be complete recovery, severe pain developed in the left side. This small calculus was then removed and the patient had an uneventful convalescence.

C.—A plain film of the lower urinary tract shows a comma-shaped calculus in the lower end of the ureter. It has the rather characteristic appearance of a stone which has lain in the ureter for a long time and increased in size in its present location. The contours are smooth and the periphery is slightly more dense than the center. The patient, a woman of 22, had been in bed for the previous five years with tuberculosis of the spine and lungs but had had no urinary symptoms. The stone was removed by ureterocystotomy.

D.—A huge calculus measuring 17.5 × 3.5 cm. is seen in the lower end of the ureter. Obviously, it has been here for a long time and has developed largely in this position, since it would be impossible for a stone of this size and shape to pass down the ureter. It is logical to assume that it developed on the basis of obstruction at the ureterovesical junction. The patient, a man of 53, had had pain in the left renal area for 40 years and had passed some stones 20 years before. The stone could be palpated through the abdominal wall. A left ureteronephrectomy was done, and pathologic diagnosis of the specimen was extreme hydronephrosis and hydro-ureter with superimposed infection.

[Calculi *continued on page 148*.]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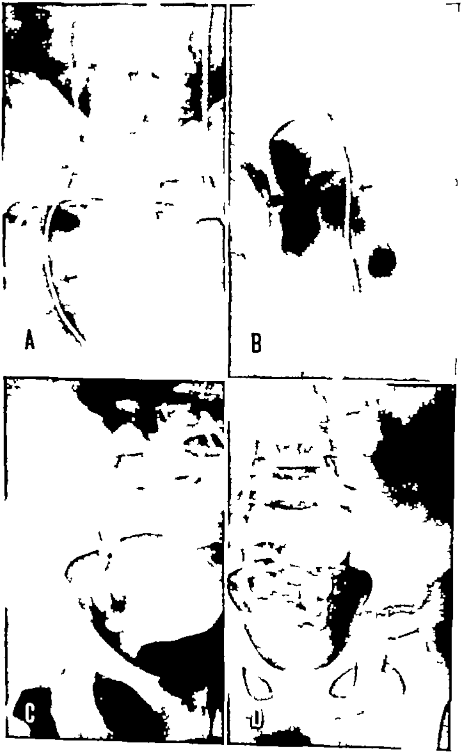
A.—A film of the lower urinary tract shows a small, round shadow of calcium density suggesting a stone at the ureterovesical junction. The upper urinary tract appears negative for stones. The patient was a man of 60 who had had renal colic on the right five days previously and several episodes of pain since then.

B.—This film of the renal area of the same patient taken following an attempted extraction shows that the small shadow has been pushed from the ureter into the renal pelvis.

C.—Film of the lower urinary tract demonstrates three shadows of calcium density lying in a row opposite the spine of the ischium. Their appearance suggests phleboliths.

D.—In the same case, after passage of an opaque catheter the upper shadow is displaced upward and lies in contact with the catheter, whereas the two lower shadows remain unchanged in position and are separated from the catheter. This indicates that the upper shadow represents a ureteral calculus which has been displaced by the catheter, whereas the two lower ones represent phleboliths. The patient, a woman aged 50, had had severe pain in the left side of the abdomen and costovertebral angle for two days. There were no urinary symptoms aside from the pain. Excretory pyelograms suggested a calculus in the lower end of the left ureter. A catheter was inserted into this side and left for 24 hours. Following its removal, a small stone about 2 mm. in diameter was passed.

[Calculi *continued on page 150*.]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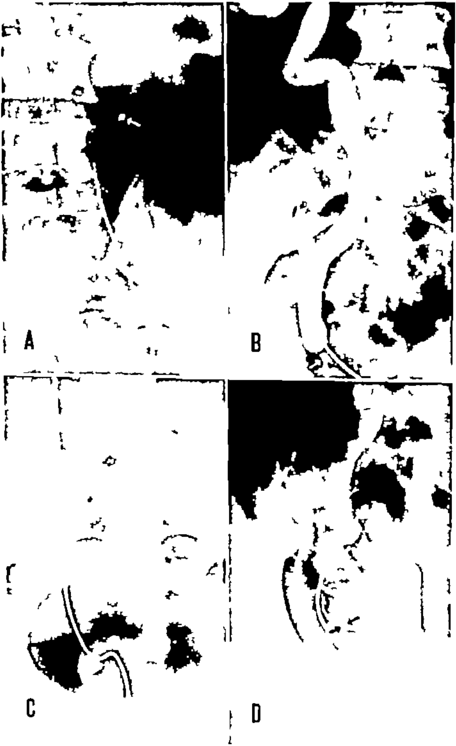
A —An anteroposterior view of the lower urinary tract shows an opaque catheter in the right ureter It appears to lie in contact with an oval shadow of calcium density, and the long axis of the shadow lies in the long axis of the ureter The shadow is slightly irregular and shows some squaring at the upper end

B —An oblique view of the same patient shows the opaque shadow still in contact with the catheter, indicating a small ureteral calculus in the region of the ureterovesical junction The patient, a woman of 48, was seen for the first time with a diagnosis of either acute appendicitis or right-sided urinary disease She had had no symptoms until the day before, when she had been seized suddenly with sharp pain in the right lower quadrant Pyelograms showed mild hydronephrosis and hydroureter on the right The patient was told to return in one week if the stone had not passed She did not return

MULTIPLE CALCULI *C* —A film of the lower urinary tract shows multiple nonfaceted calculi in the lower end of the ureter The patient, a woman of 50, had had the first attack of renal colic 24 years previously and many since then At operation, the right ureter above the stones was dilated and filled with pus The stones were composed of calcium phosphate

D —An excretory urogram shows a large dilated left ureter containing multiple faceted calculi with dense centers and peripheries with intermediate zones of low density The patient was a boy of 6 with a three year history of attacks of fever, malaise, pyuria and pain A left nephro-ureterectomy was done, and six months later he was symptom-free

[Calculi *continued on page 152*]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A—An opaque catheter in the lower portion of the ureter following excretory urography A small shadow of calcium density overlies the transverse process of the fourth lumbar vertebra This is not in line with the catheter, but the shadow is definitely in the ureter, which follows a tortuous course This film is shown to demonstrate the fact that if the ureter is redundant, a stone may lie either medial or lateral to the end of an opaque catheter Unless, therefore, the catheter lies in contact with a suspected shadow, a stone cannot be positively ruled in or out Excretory pyelograms showed good function on the left with little or no damage to the kidney This fact and the small size of the stone were considered as contraindications to its removal, since it might pass spontaneously

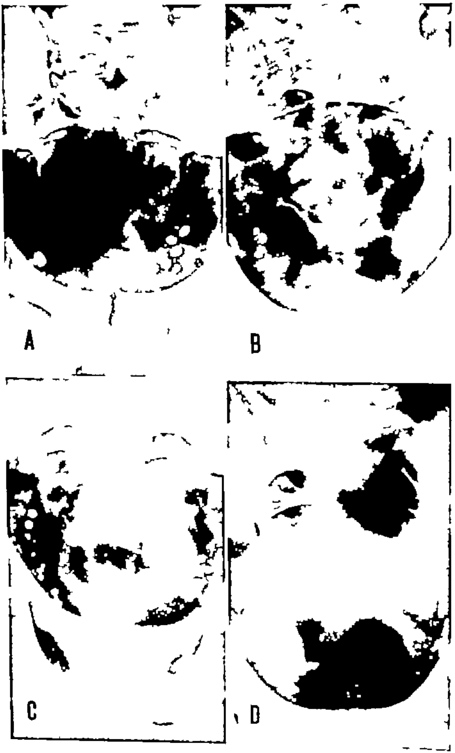
B—Ureterogram showing elongation and widening of the ureter, apparently resulting from the small calculus at the ureterovesical junction The patient had had symptoms for two months

URETEROCELE CONTAINING STONES This condition can be suspected on stereoscopic anteroposterior plain films when the stones are grouped to one side and lie anteriorly in the vesical area On air cystograms, a ureterocele of sufficient size is shown as a spherical filling defect in the region of the ureteral orifice

C—Air cystogram showing a typical right ureterocele containing calculi The diagnosis was confirmed cystoscopically The mass was resected and the stones removed

URETEROVAGINAL FISTULA Fistulous tracts are easily demonstrated when they can be filled Unfortunately, it is not always possible to fill them with opaque medium

D—Cystoscope in the bladder with opaque medium outlining the right ureter, fistulous tract and vagina The fistula followed a self-induced abortion three months previously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PHLEBOLITHS These calcifications, frequently found in association with the pelvic venous plexuses of middle-aged and elderly people, are of no clinical significance in themselves. In the presence of a suspected ureteral calculus, however, they may lead to great difficulty in differential diagnosis.

As a group, phleboliths have a typical appearance. They occur multiply on either side of the bladder, laterally and inferiorly below the level of the ischial spines. Phleboliths are usually rounded or oval, have smooth borders and do not have the irregularities sometimes seen in ureteral stones. The margins are sharp and clear-cut, while the interiors usually show some variation in density. They usually vary between 5 and 10 mm. in diameter.

In a specific instance, however, it may be impossible to differentiate a phlebolith from a ureteral calculus on the plain film. It may be necessary to identify the ureter by means of an opaque catheter or ureterogram and obtain anteroposterior and oblique radiographs to establish the relationships of a suspected shadow and the ureter.

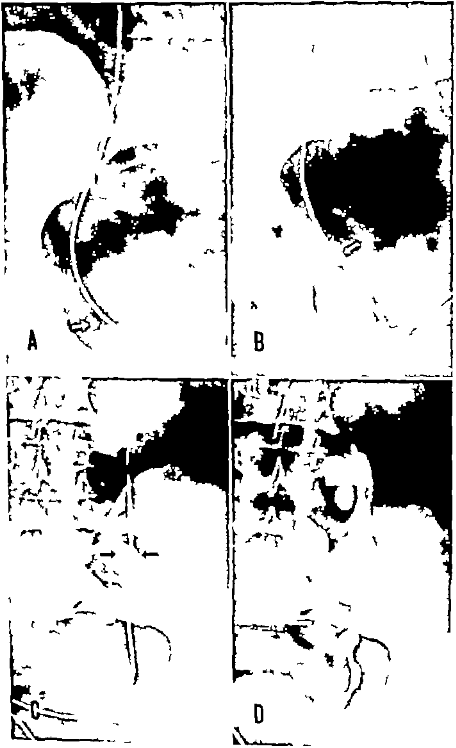
A.—Typical multiple phleboliths in a man aged 71. These were discovered incident to an examination for carcinoma of the bladder.

B.—Typical phleboliths, except that they are mainly unilateral. This patient, a man aged 69, was seen because of benign hyperplasia of the prostate.

C.—Typical multiple phleboliths in a man of 77 who had had hyperplasia of the prostate.

D.—Typical phleboliths, with one large oval phlebolith on the left side. The patient, a man of 66, was seen for symptoms of benign prostatic hyperplasia.

[Phleboliths *continued on page 156*.]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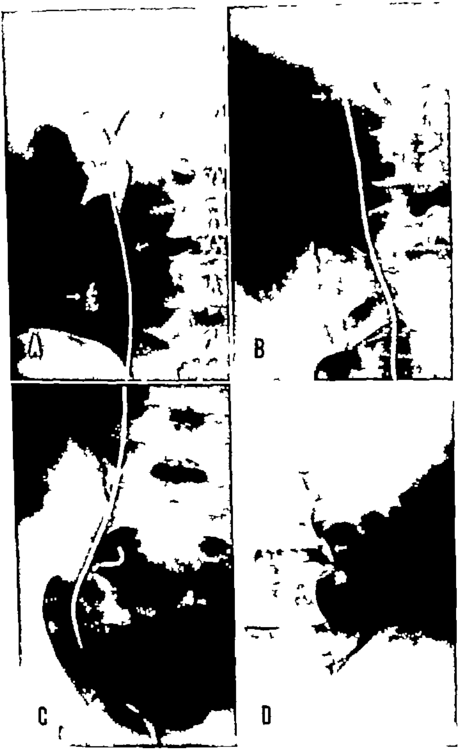
A.—Anteroposterior films of the lower urinary tract with an opaque catheter in place. The catheter lies close to but does not touch the opaque shadow. In view of the distance between the catheter and the shadow, the latter probably represents a phlebolith rather than a calculus.

B.—Oblique film of the same patient showing superimposition of the calcium shadow and the catheter. If this were a stone, the shadows should be superimposed on both exposures. Excretory urograms did not outline the lower ureter, but the shadow of calcium density was observed. An opaque catheter was placed in the right ureter and a retrograde pyelogram made. The shadow was definitely not related to the ureter and was obviously a phlebolith.

STONE IN ECTOPIC KIDNEY. *C*.—A single anteroposterior film of the lower urinary tract showing an opaque catheter lying in contact with an oval shadow of calcium density. This is somewhat larger than the usual ureteral calculus, but its oval shape and the direction of its long axis suggest that it is a ureteral stone.

D.—Retrograde pyelogram of the same patient showing obscuration of the calculus and demonstration of a renal stone in an ectopic kidney rather than a ureteral calculus, which one might suspect from the first film. The patient, a man of 29, gave a history of having passed a stone 10 years before, following which he was asymptomatic for eight years. About five weeks before admission he had had severe colic and pain in the left lower quadrant with some vesical symptoms for a week. When seen at pelviolithotomy, the kidney was of about normal size and consistency, was unascended and unrotated, with the pelvis anterior.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SHADOWS SIMULATING CALCULI Calcified mesenteric lymph nodes may simulate ureteral calculi As a rule, lymph nodes have a characteristic "mulberry" appearance and are movable, and multiple films will show slight change in position of the nodes in relation to a catheter, They cast dense shadows owing to their calcium content and are likely to be irregular in outline

A—A large calcified lymph node above the crest of the ilium shows a typical appearance A smaller node lies close to the catheter in the region of the upper end of the ureter The retrograde right pyelogram was entirely negative, which is a point against the shadow's being a ureteral stone

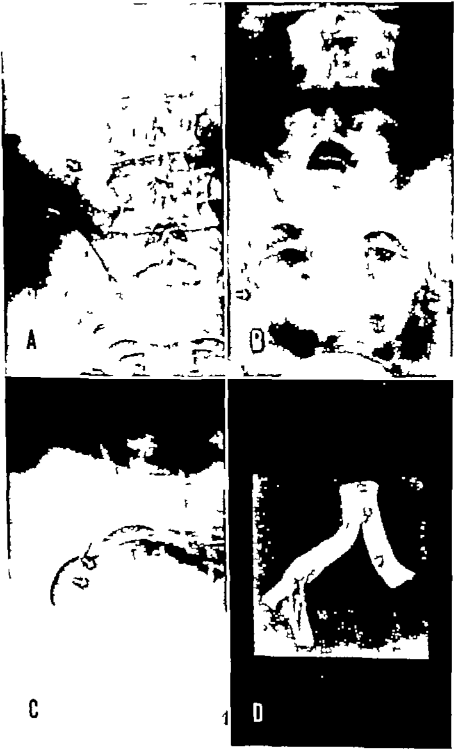
The ends of the transverse processes of the lumbar vertebrae, particularly in heavy-set individuals, are likely to cast dense shadows owing to the tangential projection of the cortex at the end of the process Such a shadow at times closely simulates a ureteral calculus, and since it lies in the region of the ureter, it may be confusing

B—The end of a transverse process of this type simulates a ureteral calculus The patient, a man of 68, had chronic prostatitis

C—An opaque catheter in the right ureter demonstrates the close relation of the tip of the appendix to the ureter This shows the possibility of confusing a fecalith with a ureteral calculus The patient, a man of 22, had had previous gastro-intestinal studies because of right lower quadrant pain suggesting appendicitis Urologic examination showed no evidence of disease

D—A detached osteophyte extends between the left lateral margins of the third and fourth lumbar vertebrae The appearance is similar to that of a ureteral calculus The patient, a man of 47, had no upper urinary tract symptoms and excretory urograms were normal

[Shadows simulating calculi *continued on page 160*]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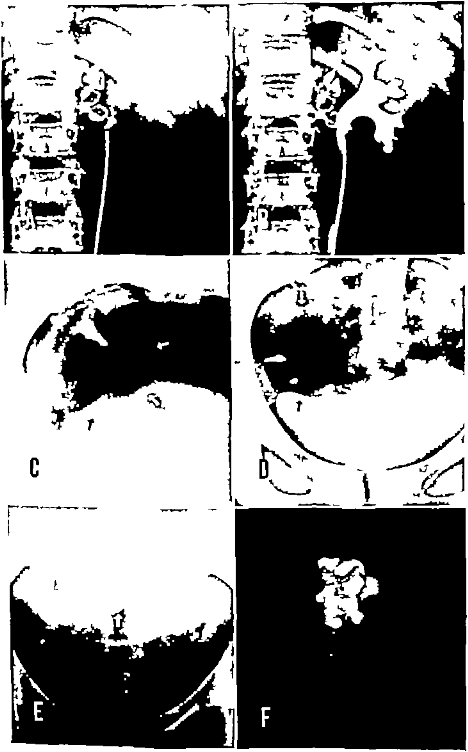
ARTEFACTS RESEMBLING CALCULI *A*.—Film of the urinary tract shows a shadow of increased density resembling a ureteral calculus but actually produced by a screen defect. Such shadows can be very confusing as they strongly suggest urinary calculi. In this instance, the patient was catheterized and another film exposed with a different cassette showed no shadow. Such shadows are always reproduced at exactly the same point on the film, and when they are suspected, their cause can be found by inspection of the screens.

VASCULAR PLAQUES RESEMBLING CALCULI
These are usually observed directly beneath the sacro-iliac joints and closely resemble ureteral calculi. They are usually bilateral, slightly irregular and tend to be multiple. They are found only in middle-aged and elderly people.

B.—This film is an excretory urogram made of a man aged 48 with teratoma of the testicle. There were no symptoms of urinary disease and the calcified plaques were incidental findings.

C.—An opaque cystogram demonstrates calcified plaques in the right iliac artery of a man of 69 who died of adenocarcinoma of the prostate.

D.—A radiograph of an anatomic specimen from the same patient shows the plaques of calcification in the iliac artery. Usually in older people the arteries calcify diffusely and can easily be identified. It is only when the calcium is deposited as plaques that there is confusion with ureteral calculi.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DERMOID CYSTS Dermoid cysts, particularly those containing bone or teeth, sometimes simulate urinary lesions The problem of differentiation can usually be solved by identification of the teeth These teeth may be in any stage of development In children, only the crowns may be calcified, while in adults, well formed teeth may be seen Frequently they can be identified as incisors, cuspids or molars, and often even the root canals can be distinguished Dermoid cysts frequently contain a sebaceous material which is less dense than the surrounding tissue, so that the tumor is visualized as an area of decreased density

These cysts usually develop in association with the ovary but may occur elsewhere Only a few patients have symptoms referable to the tumor, such as pressure symptoms or pain from a twisted pedicle Most are discovered at examination incident to pregnancy or during study of the urinary tract

A.—Dermoid cyst with numerous partially developed teeth in a girl of 10

B.—Same patient, showing relationship of the cyst and renal pelvis

C.—Well developed molar in a dermoid cyst containing sebaceous liquid more radiolucent than surrounding tissue Cystoscopy showed the pressure defect on the bladder

D.—Well formed incisor with two less well developed teeth in a dermoid cyst composed of less dense sebaceous material

E.—Single tooth visible behind the head of a 6 month fetus The dermoid was removed without interrupting the pregnancy

F.—Dermoid showing teeth and bone in detail This was removed from a woman of 25 with no urinary symptoms


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Diseases involving the renal pelvis are likely also to involve the ureter, but the ureteral changes are frequently overlooked because of more obvious ones in the kidney

TUBERCULOSIS Long-standing renal tuberculosis characteristically involves the ureters and produces multiple strictures having a "beaded" appearance If the kidney has continued to function, there may be some dilatation above a stricture There may also be calcification in the ureteral wall

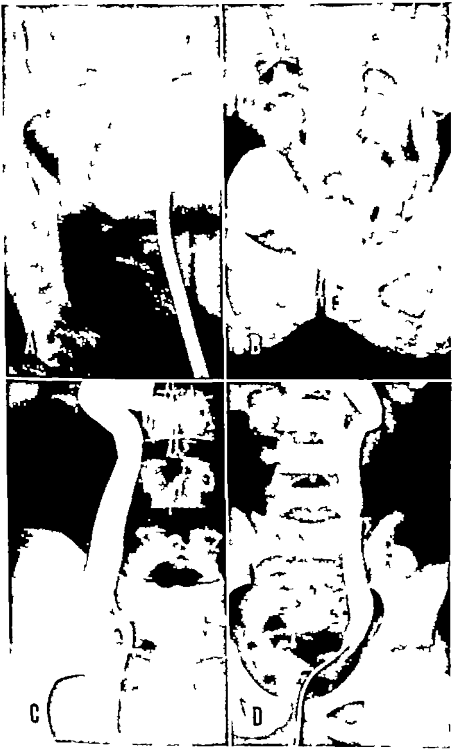
A —Left ureterogram showing narrowing and irregularity of the ureter throughout its length, with the "beaded" appearance characteristic of tuberculosis The patient, a man of 39, had tuberculosis of bone also Catheterized specimens of urine from the left ureter were positive for acid-fast organisms and an inoculated guinea-pig showed tuberculosis

B —"Beaded" calcification along the lower ureter caused by tuberculosis The patient had no urinary symptoms at the time of death from gastric carcinoma Autopsy revealed typical tuberculous putty kidney on the left

NEOPLASM Primary tumors of the ureters are rare Keen and Bernstein in reporting a case state that only about 150 cases have been reported, of which two thirds have been added in the last eight years On the other hand, implants in both ureter and bladder are common with primary neoplasms of the renal pelvis

C —Retrograde urogram showing multiple neoplastic implants four years after nephrectomy for papillary carcinoma of the renal pelvis

D —Filling defects in the lower ureter having the appearance of implants The smooth defect in the upper ureter suggests blood clot Autopsy showed an epidermoid carcinoma of the renal pelvis with generalized metastasis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URETERECTASIS Any lesion producing obstruction to the ureter, bladder or urethra such as calculi, congenital and acquired stricture, benign and malignant neoplasms and infection may lead to ureterectasis The urogram in this condition shows dilatation and elongation of the ureter The outline is smooth except in cases of long-standing infection, which usually produces irregularity

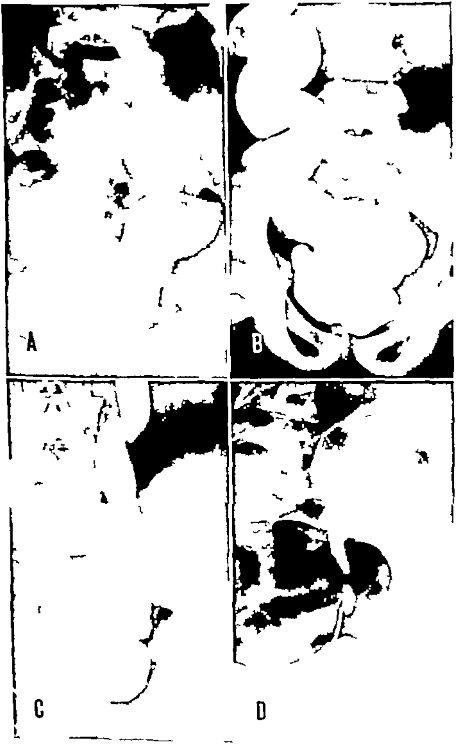
A —Opaque cystogram shows a filling defect in the bladder from prostatic hyperplasia with reflux up the right ureter, which is dilated and elongated The patient, aged 71, had had symptoms of vesical neck obstruction for several months, with complete retention one week prior to admission

B —Opaque cystogram shows a vesical diverticulum on the right, with reflux into the dilated, elongated, irregular left ureter The irregularity of the ureter suggests a complicating infection, and much pus was found in the urine The patient, aged 72, had had symptoms of prostatic obstruction for a year and a half

C —Ureterogram shows widening and elongation of the upper two thirds of the ureter The ureter was found to be partially obstructed by an appendiceal abscess which was drained Aside from ureterectasis and hydronephrosis, the patient, a woman aged 30, had no abnormal findings in the urinary tract

D —Ureterectasis in a boy of 8 Cystoscopy revealed a ureterocele with a small orifice, and it was believed that there was a congenital stricture at the ureterovesical junction responsible for these findings

[Ureterectasis *continued on page 168*]



A.—Opaque cystogram shows reflux into a huge dilated, tortuous ureter in a man of 30 with a history of a ruptured bladder four months previously. A stricture or congenital valve was suspected, but it could not be found either on cystoscopy or at ureteronephrectomy. Certainly the ureterectasis is of long standing, and the ruptured bladder was incidental rather than causative.

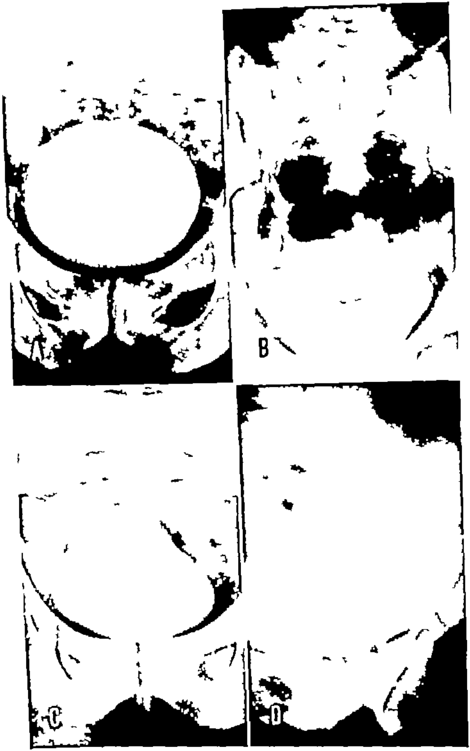
B.—Opaque cystogram shows a vesical diverticulum, with reflux into both ureters, the right being greatly dilated, elongated and coiled. The patient, a child of 8, had no urinary symptoms. A tonsillectomy was to have been done, and a routine urinary examination showed pus, albumin and red blood cells. Cystoscopy revealed two congenital valves in the prostatic urethra, one on either side.

URETERECTASIS FROM CHRONIC INFECTION ACCOMPANYING PYELONEPHRITIS. *C*.—Ureterogram shows a dilated, tortuous ureter which is slightly irregular and lacks the smooth contours seen in the absence of chronic infection. The patient, a woman aged 51, had a history of recurrent urinary infection for 26 years.

D.—Stricture of the ureter from tuberculosis is associated with some dilatation above the point of narrowing. The patient, a woman aged 54, had tuberculosis of the left kidney. The urine from this side was positive for acid-fast organisms and a guinea pig inoculation of the urine also showed the disease. A left nephro-ureterectomy was done, and the ureter was found as a fibrous cord in the upper portion but was dilated to five or six times its normal diameter distally. Pathologic diagnosis was chronic granuloma probably tuberculous. Guinea-pig inoculation with tissue also gave positive results for tuberculosis.

The Bladder

ROENTGEN EXAMINATION The roentgen examination of the bladder should be as nearly complete as possible. While it is true that certain lesions may be revealed by its visualization following excretory urograms, or at times from a flat film of the urinary tract in the case of some vesical calculi we believe that the minimal requirement for a satisfactory study of the bladder consists of at least three films (1) a flat film of the vesical area (2) an opaque cystogram and (3) an air cystogram. Further studies may be indicated. It is frequently advisable to obtain films in the right or left oblique positions The flat film of the vesical area is necessary to rule out lesions of greater density such as calculi calcification in and around the bladder and opaque foreign bodies The opaque cystogram shows the size outline, position and shape of the bladder and may reveal tumors, trabeculations, diverticula rupture prostatic enlargement etc. The air cystogram is of particular value in showing tumors which project into the bladder and which may be obscured by overlying opaque medium. It also aids in the study of diverticula the prostatic filling defects in the bladder and nonopaque calculi Oblique views are of special value in the study of diverticula and tumors, which are best demonstrated when observed tangentially Both air and opaque cystograms are helpful in demonstrating placenta praevia by showing the distance between the fetal head and the vesical wall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THE NORMAL BLADDER The normal bladder is best demonstrated by an opaque cystogram. The walls are smooth, but contour varies between individuals and is influenced by the amount of distention. It may be round or oval with the greatest diameter lying in the horizontal, vertical or anteroposterior axis. In the third instance, there is likely to be a double shadow on the anteroposterior cystogram which must not be mistaken for a diverticulum. In cystograms of women, there is likely to be a defect on the upper surface from pressure of the uterus.

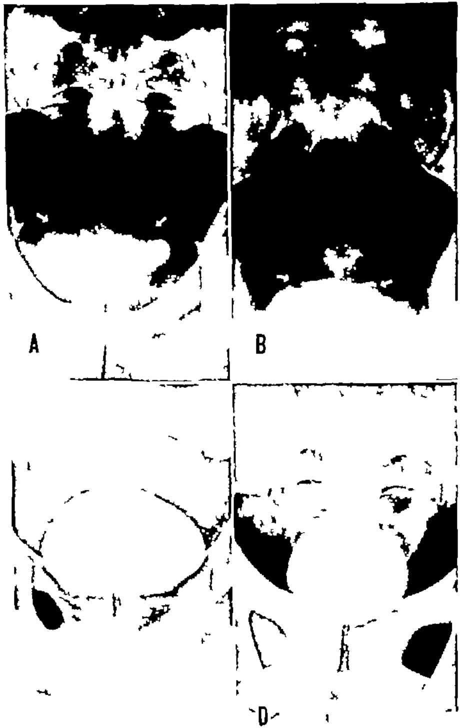
A.—Sodium iodide cystogram of a man of 73 with slight prostatic hyperplasia. He had never been catheterized and gave no history of hematuria, passage of stones, chills, fever or backache. The bladder is slightly oval and the walls are smooth without trabeculation.

B.—Visualization by excretory urography. The bladder is not fully distended and shows a pressure defect from the uterus. The patient, a woman of 44, had symptoms referable to the ureteral calculus on the right immediately above the bladder. The vesical wall is smooth and of normal appearance.

C.—Sodium iodide cystogram showing a large oval shadow with greatest diameter in the transverse axis and a superimposed round shadow. At first one might suspect diverticulum. However, outlines of both shadows are perfectly smooth and neither shows trabeculation. Double shadows are obtained in oval or conical bladders with superimposition of the anterior portion over the posterior portion of the bladder.

D.—Oblique cystogram of the same patient giving a better idea of the vesical outline and showing the anterosuperior above the postero-inferior portion. It is obvious how a direct anteroposterior projection produces a double shadow resembling, but not to be mistaken for, a diverticulum. The patient, a man of 69, had slight prostatic hyperplasia.

[Normal bladder *continued on page 176*.]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The interureteral ridge is occasionally demonstrated in partially filled bladders. It is seen more commonly in men than in women, and it is not unusual to observe it in partially filled bladders observed during routine examination of the urinary tract by means of excretory urograms. It is a normal anatomic structure, however, and should be recognized as such. Edling has pointed out that a change of contour at one end of the interureteral ridge may lead one to suspect a ureteral calculus where it might not otherwise be suspected. He also mentions the possibility of its being of assistance in the diagnosis of tumors in this location. We have not yet found it of any value in the diagnosis of either calculi or tumors, however.

A.—Bladder of a youth of 20 following excretory urography. The interureteral ridge is well seen, is symmetrical and entirely normal in appearance. Its visualization in this patient was incidental.

B.—Cystogram of a man of 41 following excretory urograms. He complained of pain in the abdomen but had no urinary symptoms or findings. The upper border of the interureteral ridge is well shown, extending as a curved line across the upper portion of the bladder.

C.—Normal oval bladder of a man of 70 who had had a stone in the left ureter three years before but no urinary symptoms since.

D.—Small normal bladder of a man of 63 with pyelonephritis but no vesical or prostatic symptoms.


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INGUINAL HERNIA This condition, also known as inguinal cystocele, is rare and is more often diagnosed by the unsuspecting surgeon at the time of hernioplasty than by the radiologist or urologist The radiographic findings are characteristic, and an opaque cystogram will demonstrate the herniated portion of the bladder in the hernial sac These hernias are usually of the direct type, produce no vesical symptoms, can occur without obstruction of the neck of the bladder and result primarily from congenital weakness of the inguinal ring When the bladder is distended, a tense mass presents in the groin, but this becomes soft and definitely smaller when the patient voids If this sequence of events occurs, the relationship between the hernia and the bladder is readily established

A —Sodium iodide cystogram demonstrating a herniated portion of the bladder within a right inguinal hernia The patient was a man of 47 who had had a painless swelling in the right groin which had varied in size but had produced no symptoms He had noticed, however, that it was larger in the morning when the bladder was full and that it would decrease in size as soon as he had voided A physical examination revealed a soft compressible but irreducible mass in the right inguinal region

B —Right oblique cystogram of the same patient, also demonstrating the herniated bladder projecting into the hernial sac

C —An opaque cystogram showing a left inguinal hernia containing a portion of the bladder The patient was a man of 72 who had had progressive symptoms of obstruction of the vesical neck for five years Examination showed mild prostatic hyperplasia with 50 cc of residual urine Physical examination showed a left direct inguinal hernia, but hernia of the bladder was not suspected until the opaque cystograms were made

D —Left oblique cystogram also showing the bladder in the hernial sac

[Inguinal hernia *continued on page 180*]


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INGUINAL HERNIA CONTAINING BOWEL The visualization of gas-filled loops of intestine in a hernial sac is a frequent coincidental observation in the radiographic examination of the lower urinary tract The herniated small bowel, in contrast to the condition when it is in the abdomen, is usually filled with gas and is therefore easily seen The colon only rarely is present in an inguinal hernia If identification of a loop of bowel is important, a barium enema will easily visualize a loop of colon

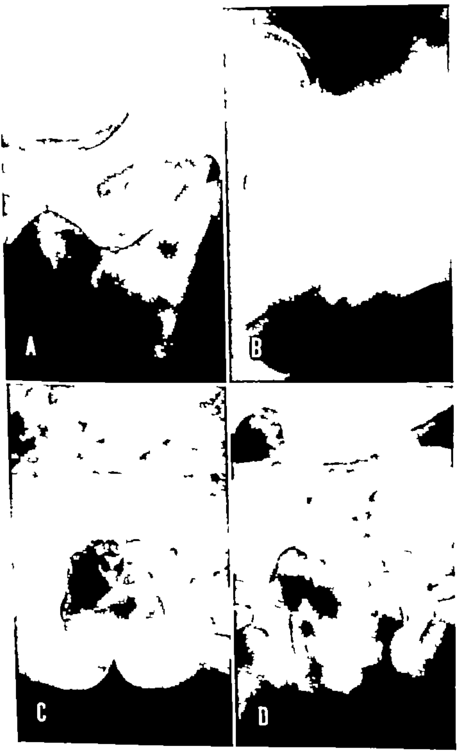
A —Opaque cystogram incidentally shows gas-filled loops of small bowel in a left inguinal hernia

B —This right oblique air cystogram shows not only a prostatic filling defect in the bladder but also loops of gas-filled intestine in a left inguinal hernia At operation this was found to be a loop of sigmoid colon

EXSTROPHY In this congenital anomaly there is absence of the anterior abdominal wall and the anterior wall of the bladder This exposes the two ureteral openings and the posterior vesical wall The accompanying changes in the bony pelvis are of interest from a radiographic standpoint The pubic bones are likely to be maldeveloped and separated about the width of the sacrum and this is accompanied by flaring of the iliac wings which gives the pelvic inlet a square rather than the usual round or oval shape These findings may be as marked with epispadias as with complete exstrophy, however

C —Wide separation and maldevelopment of the pubic arch accompanying exstrophy of the bladder in a boy 2½ years old

D —Exstrophy of the bladder in a boy of 3 years The ureters had been transplanted, and the film taken following excretory urography shows some opaque material in the rectum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CALCULI Calculi in the bladder are formed from the same salts and combination of salts that compose renal calculi. In fact, many of the stones found in the bladder undoubtedly had their origin in the kidney and have passed through the ureter into the bladder. Stones composed of uric acid and urates, however, are commonly found in the bladder, whereas in the kidney they are rare. The typical mulberry calculus of calcium oxalate in the bladder can usually be identified as such. The oxalate stone may also assume another form, the so-called "jack stone" calculus, which is also typical. Vesical calculi are frequently multiple and may be faceted. They occur most frequently in men past middle age and in those having some urinary obstruction. Stones containing sufficient calcium, namely, the oxalate and the phosphate calculi, are easily seen on plain radiographs. However, the urate and uric acid stones, which are also common in the bladder, are of low density and will not be observed on a plain film. They can usually be well demonstrated by means of air cystograms, since the air forms a contrast medium less dense than the stones. Occasionally, they can also be observed as negative filling defects in opaque cystograms. This is particularly true in bladders which are not completely filled and more especially when a medium of relatively low density has been used. If the stones are small, however, the opaque medium may obscure them. (*See also* illustrations, pages 184 ff.)

Foreign Bodies and Associated Calculus Formation.—Foreign bodies that may enter the bladder fall in three categories. The first, and most common, are instruments such as catheters or fragments of catheters, which may have been introduced by the patient or his physician during treatment, or any substance or material whose size and shape permit introduction into the urethra for the purpose of masturbation. These are as varied as the objects that can be introduced and "lost up the urethra." The second are foreign bodies, which fortunately are rare, such as sponges and fragments of needles which at operation are left either in or near the bladder and later erode through the vesical wall. The third are those which enter the bladder through penetrating wounds.

Any foreign body that remains in the bladder for a considerable period of time acts as a nidus on which calcium salts are soon deposited. It may be difficult to distinguish stones formed about some foreign bodies from the ordinary vesical stones. On the other hand, if a foreign body is opaque the nidus can often be easily recognized radiographically. Foreign bodies such as sponges left in the peritoneal cavity may erode through the vesical wall and produce filling defects in the opaque and air cystograms indistinguishable radiographically from tumors. (*See also* illustrations, pages 190 ff.)

[Calculi *continued on page 184*.]

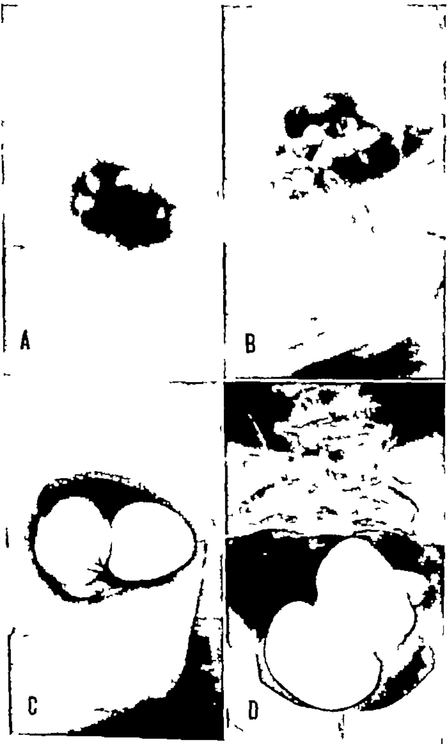
A.—This oblique air cystogram demonstrates numerous vesical calculi. The stones are of very low density and could not be seen on the plain film. Here, however, they are readily discernible because they are more dense than air. The patient was a man of 77 whose urinary stream would suddenly shut off but would start again with change of position. Examination showed a slight enlargement of the prostate and 13 stones in the bladder. These were crushed and found to be composed of uric acid.

B.—This oblique air cystogram demonstrates multiple calculi of low density in the bladder. A prostatic filling defect can also be observed as well as rough trabeculations of the vesical wall. The patient was a man of 73. Examination showed moderate benign enlargement of the prostate. The stones were crushed and the prostate resected transurethrally. The stones have centers of low density surrounded by rings of greater density, suggesting that they might be urate or uric acid centers with calcium phosphate peripheries.

C.—This air cystogram shows two large and two smaller calculi of rather uniform density, although some laminations can be made out. The patient was a man of 81 with slight enlargement of the prostate. The stones were removed suprapubically. The largest weighed 106 Gm. and total weight of the four stones was 192 Gm.

D.—One small and two large calculi are of uniform density and located in the bladder. The patient was a man of 55 who began to have pain in the abdomen with hematuria six months before. The prostate was small and benign. The stones were removed by cystolithotomy. Analysis of the smallest showed calcium phosphate.

[Calculi *continued on page 186*.]



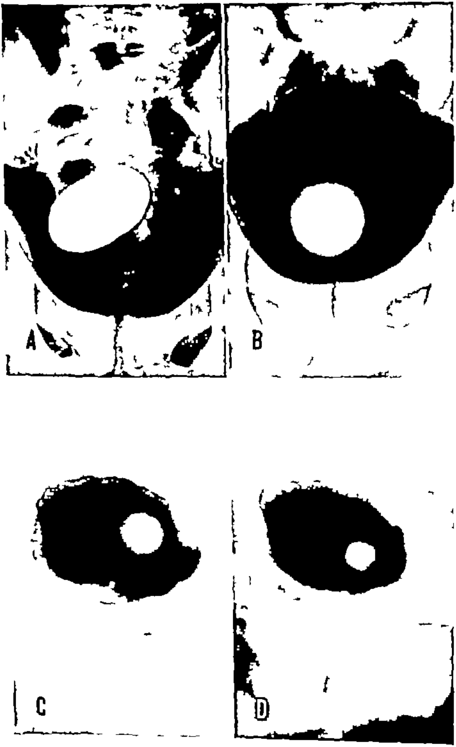
A —A flat film of the vesical area demonstrates a large, dense oval calculus in the bladder The patient was a man of 74 with hyperplasia of the prostate and 135 cc of residual urine No stones had ever been passed and there had been no gross hematuria A cystolithotomy was done, and the removed stone weighed approximately 100 Gm

B —A nearly spherical calculus of considerable density shows definite laminations The patient was a man of 64 with a history of gonorrhea 43 years before Two years previously a stone had been removed by suprapubic cystotomy Urethrographic studies demonstrated a gonorrheal stricture of the anterior urethra, but there was no prostatic enlargement The urethral stricture was dilated and the stone crushed On analysis the composition of the stone was found to be principally calcium and ammonium phosphates, with small amounts of oxalates and urates

C —An air cystogram shows a round calculus in the bladder in addition to a prostatic filling defect in the bladder A transurethral resection of the prostate and litholapaxy were done Analysis of the stone showed it was composed chiefly of calcium carbonate but with some phosphate Pathologic diagnosis was hyperplasia of the prostate

D —An oblique air cystogram demonstrates a laminated vesical calculus The patient, a man of 51, complained of frequency, burning and smarting, and the prostate was slightly enlarged The stone was crushed and a transurethral prostatic resection done

[Calculi *continued on page 188*]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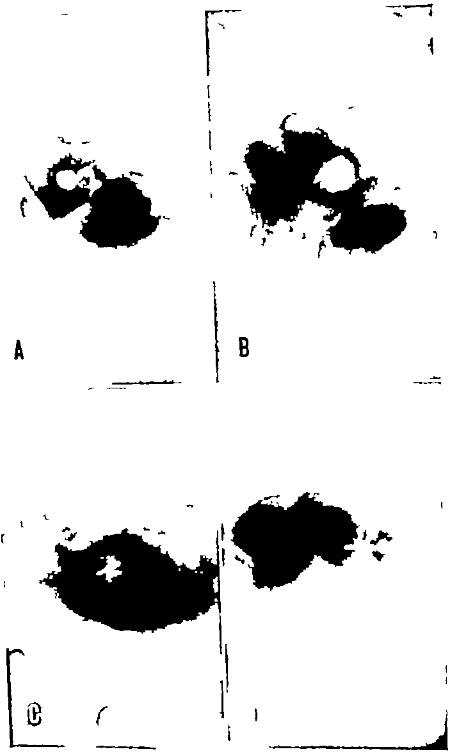
A.—An air cystogram shows three ring-shaped stones with less dense centers and a filling defect in the bladder from benign prostatic hyperplasia. The patient was a physician of 83 who had been catheterizing himself once or twice daily for 20 years. The prostate was resected and the stones crushed. They were found to be composed of triple phosphate and calcium carbonate.

Calcium Oxalate Calculi.—Oxalate stones in the bladder can usually be diagnosed from their characteristic radiographic appearance. They may assume one of two forms: the mulberry calculus, in which many fine spicules are seen radiating from the center of the stone, and the jackstone, in which the spicules are coarse, few in number and club-shaped at their outer ends. Cystoscopically, these stones can also be recognized by their shape and black color.

B.—A typical mulberry calculus shows fine radiating spicules. A large prostatic filling defect is also seen in the bladder. A transurethral resection and litholapaxy were done. Analysis of the stone showed calcium oxalate. Pathologic diagnosis was hyperplasia of the prostate.

C.—An air cystogram demonstrates a typical jackstone or calcium oxalate calculus. Litholapaxy was done. The stone was analyzed and found to be pure calcium oxalate.

D.—A right oblique air cystogram demonstrates a typical jackstone calculus lying posterior to the intravesical protrusion of the prostate. This radiographic appearance of widely separated radiating spicules with clubbed ends is typical of a calcium oxalate stone. Through the cystoscope, the black color and jackstone shape of a typical oxalate calculus were also apparent.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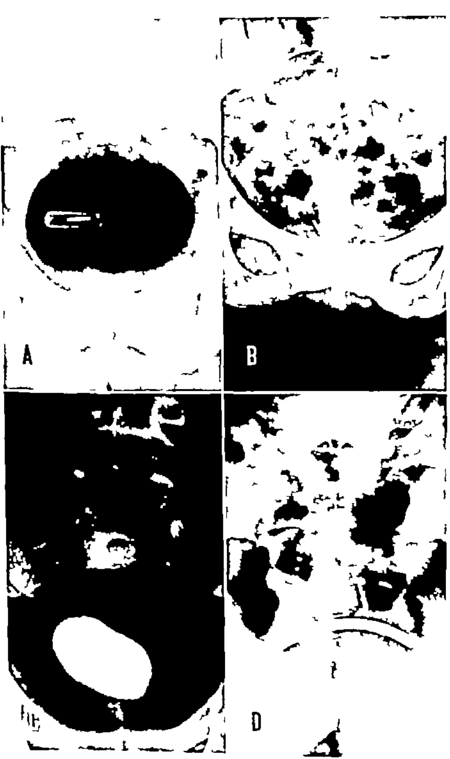
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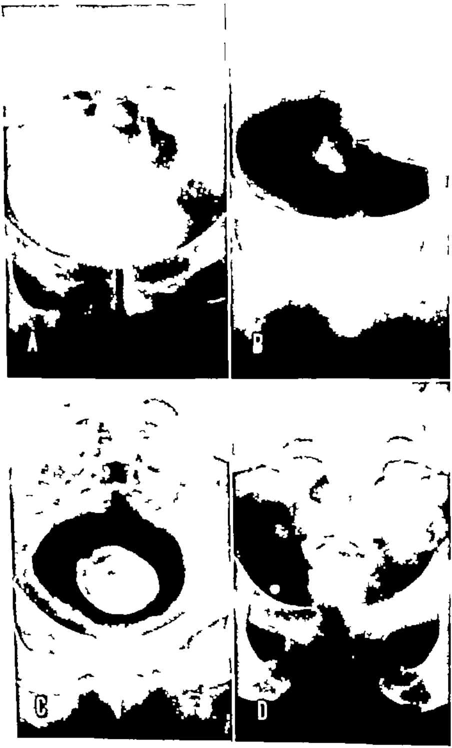
FOREIGN BODIES *A*—An air cystogram shows an opaque cylinder surrounded by calcium salts lying within the bladder This is obviously due to calcium deposited around a foreign body The foreign body was found during the routine roentgen examination of the urinary tract A cystotomy was done, and a small glass vial, 1 1/8 × 3/8 in, with a rubber band attached was found Both the vial and rubber band were incrusted with calcium salts After removal the patient admitted that he had inserted the vial into the urethra about six months before

B—A stone has obviously formed around a fragment of a curved needle The patient, a woman of 63, stated that she had had radium treatment followed by a hysterectomy 13 years before Immediately afterward there had been drainage of urine from the vagina which had continued to the present time No urine had been passed from the urethra since the operation The foreign body shown on the film, which was taken after stones had been removed from the vagina and bladder, was apparently in the fistulous tract

C—A laminated calculus shows a straight center of decreased density The patient had put a match in the urethra two years before Lithotomy yielded a stone with a well preserved match at its center Analysis of the fragments of the calculus showed triple phosphates and calcium carbonate

D—A fragment of catheter lies transversely in the bladder The patient, a man of 75, had had complete retention from hyperplasia of the prostate for five years and had catheterized himself twice daily throughout the period The night prior to admission the catheter had broken off in the bladder

[Foreign bodies *continued on page 192*]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A —An opaque cystogram shows an irregular filling defect in the left upper quadrant of the bladder The right half of the bladder appears smooth and normal

B —An air cystogram of the same patient demonstrates the filling defect to better advantage This shows a tumor-like mass projecting into the bladder, with an area of induration and rigidity of the vesical wall in the left upper quadrant This appearance is indistinguishable from that produced by a neoplasm The patient, a woman of 62, had tenderness and muscular rigidity in the left suprapubic area and gave a history of frequency and increased irritability of the bladder She had had a hysterectomy four months previously, and symptoms had been present for about six weeks There had also been some hematuria A gauze sponge with much necrotic tissue was removed by suprapubic cystotomy The sponge had been recognized preoperatively through the cystoscope

C —A lime-incrusted foreign body suggests calculus, but its mottled, irregular density is certainly different from that of the usual stone The patient, a woman of 69, had had a vaginal operation for repair of a cystocele one year before Shortly thereafter she had passed gas and fecal material per urethra Six months before admission the fistula was repaired with good results except that she continued to have burning and frequency of urination A suprapubic cystotomy was done and the foreign body was found to be a sponge incrusted with calcium salts

D —A conglomerate mass of calcium within the vesical area is hardly discrete or dense enough to be a calculus and was found at operation to be an incrusted surgical sponge The patient had had a suprapubic prostatectomy elsewhere two months previously for benign hyperplasia


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CYSTOGRAPHY IN SUSPECTED PLACENTA PRAEVIA
Ude and his co-workers were the first to show the value of cystography *in suspected placenta praevia* In the third trimester of pregnancy, with the head presenting and the bladder outlined by a contrast substance, the distance between the fetal skull and the interior of the bladder as measured on the film is normally slightly over 1 cm With central placenta praevia, this distance is increased by the width of the placenta which forms a soft tissue shadow between the fetal skull and the bladder With marginal placenta praevia, the soft tissue shadow and increased distance will be on the side of implantation

Prentiss and Tucker prefer air as a contrast medium and find it advantageous to obtain right and left oblique films in addition to the anteroposterior. They believe that some posterior marginal implantations can be demonstrated in this manner that would be overlooked *in the single anteroposterior view*

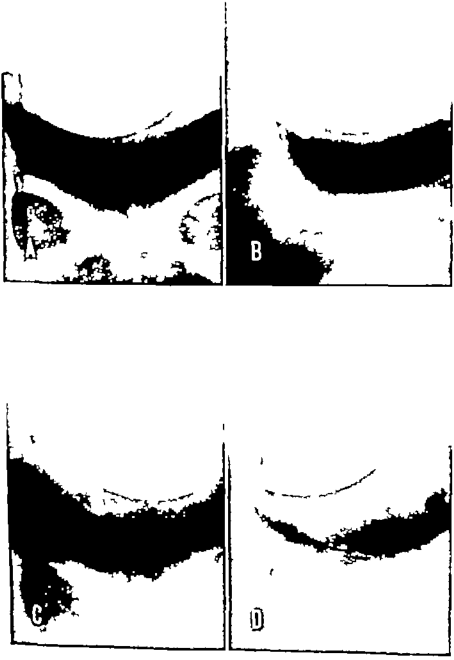
A.—Anteroposterior air cystogram showing the usual distance between the fetal skull and the bladder in the absence of placenta praevia.

B—Right oblique air cystogram of the same case

C—Anteroposterior air cystogram showing elevation of fetal head from interposition of a placenta praevia The fetus is at term.

D.—Right *oblique* view *of the same patient also demonstrating* the interposed placenta This patient had had two episodes of vaginal bleeding. A low cervical cesarean section was done, and the placenta was found centrally located over the internal os

[Placenta praevia *continued on page 196*]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A—This opaque cystogram shows the fetal head within the lower uterine segment and definitely separated from the left side of the bladder This indicates a placenta praevia which lies more to the left side than to the right The patient, a primigravida at term, had had repeated vaginal bleeding At cesarean section most of the placenta was found on the left side of the lower uterine segment covering the internal os

Complicating Factors in Diagnosis—Breach or transverse presentations, soft tissue tumors, malformations of the fetus or of the maternal pelvis and blood clot in the lower uterine segment are complicating factors which may lead to errors of diagnosis

B—The back of this 6 month fetus lies well above the bladder While at cesarean section the placenta and a large blood clot covered the entire internal os, the small size and position of the fetus make it doubtful if one is justified in making a diagnosis of placenta praevia in this case on the roentgen findings alone

DEMONSTRATION OF THE PLACENTA IN THE FUNDUS

The simplest step in locating the placenta is to obtain antero posterior and lateral views of the abdomen This will show the normal placenta in the fundus in a high percentage of cases, according to Snow and Powell Demonstration of a placenta in the fundus obviously rules out the possibility of placenta praevia where there is only one fetus

C—A lateral film of the abdomen taken on the day of delivery of a term fetus shows the placenta implanted normally in the fundus anteriorly

ECTOPIC PREGNANCY ATTACHED TO BLADDER

D—This patient was seen because of recent hematuria Cystoscopy showed perforation in the left side of the vesical wall from which blood was coming The mass was visualized by injecting opaque material through a catheter inserted into the opening Exploration revealed an ectopic pregnancy between the leaves of the broad ligament


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INFECTIONS Except for cystitis emphysematosa, the radiograph offers little assistance in diagnosis of cystitis It may show abnormalities in other infections, but these can usually only be interpreted in the light of cystoscopic, laboratory and clinical findings

Cystitis Emphysematosa —As pointed out by Lund, Zingale and O'Dowd, a radiolucent ring due to gas in the vesical wall can be observed with cystitis emphysematosa This rare condition is most frequently found in diabetic patients with colon bacillus infection

A —This opaque cystogram shows a thin radiolucent ring of gas in the vesical wall of a diabetic of 91 with high blood sugar

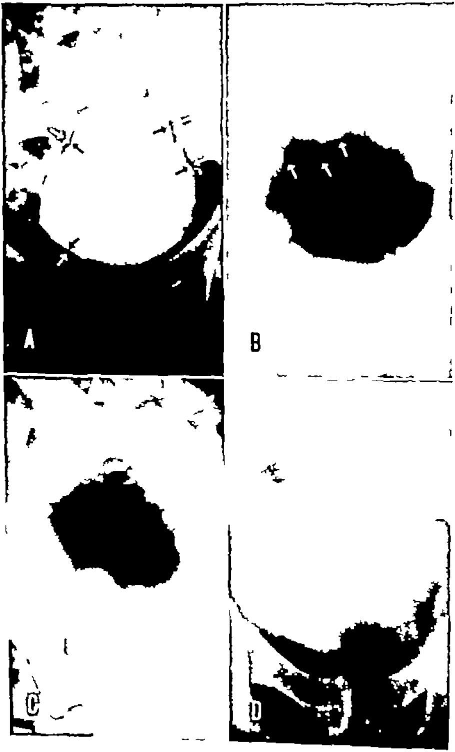
Actinomycosis —*B* —This air cystogram of a farmer of 22 with actinomycosis is in no way diagnostic but does show a wavy infiltration in the dome of the bladder An exploratory operation showed infiltration of the suprapubic area by hard malignant-looking tissue Pathologic diagnosis was typical sulfur granules of actinomycosis

Perivesical Abscess —The vesical wall overlying an abscess is rigid, flattened and irregular and the whole bladder may be displaced If the abscess has broken through into the bladder, the fistulous tract as well as the abscess cavity may be visualized by opaque cystography

C —This oblique air cystogram shows elevation of the bladder with flattening and irregularity from a perivesical abscess, at operation found extending around the vesical neck

D —The bladder is slightly elevated and displaced to the right by an extravesical mass producing some induration and irregularity of the wall At operation an abscess containing several ounces of pus was found in the perivesical space near the vesical neck

[Infections *continued on page 200*]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A.—Opaque cystogram showing an irregular bladder, with a communicating perivesical abscess Cystoscopy revealed a small opening into the bladder just above and to the right of the ureteral orifice Catheterization of this fistula yielded fecal fluid The patient was treated conservatively and two months later was asymptomatic

B.—Rectovesical fistula shown by visualization of the lower colon by opaque medium injected into the bladder The patient, 26, fell on a pitchfork handle that passed into the rectum Both feces and urine were passed per urethra The fistula healed following colostomy

RUPTURED BLADDER This is usually caused by direct trauma over a full bladder The rupture as demonstrated by cystography is of one of two types (1) extraperitoneal, in which the urine and opaque material diffuse into the extraperitoneal tissues and remain rather localized, and (2) intraperitoneal, differentiated from the former by the fact that the bowel is likely to be outlined by the opaque medium surrounding the intestinal loops The necessity of using nontoxic and nonirritating opaque mediums is obvious

C.—Opaque cystogram demonstrating extravasation of opaque material into the peritoneal cavity The communication with the peritoneal cavity is evidenced by visualization of loops of bowel The patient, a man of 46, had had pain and been unable to void immediately after a fall The prevesical space was explored and found normal Opening of the peritoneum disclosed a rent in the dome of the bladder and blood in the peritoneal cavity

D.—Left oblique cystogram showing extravasated opaque medium extraperitoneally in the soft tissues of the anterior abdominal wall above the bladder The patient, a boy of 12, had been struck by a car On attempting to void he passed a few drops of blood The peritoneum was opened and no fluid found The prevesical space was filled with blood clots, and two rents in the bladder were repaired


B
C
D

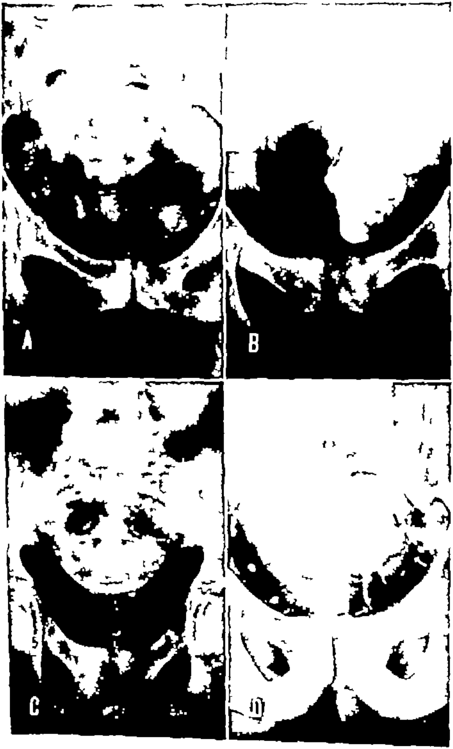
CALCIFICATIONS IN THE PELVIS Calcifications in the pelvic area are common and at times may be confused with urinary conditions Some of these, such as fibroids of the uterus, are rather common and have a characteristic appearance They are usually located relatively high in the pelvis above the bladder, and if cystograms are made there is no difficulty in differentiating them from vesical lesions

A —Fibroid of the uterus showing a typical irregular deposit of calcium The patient, a woman of 58, was seen because of fracture of the hip The finding of the calcified fibroid of the uterus was entirely incidental

B —Another calcified fibroid of the uterus The fibroid is more dense but still appears typical The patient, a woman of 53, had carcinoma of the bladder, and the finding of the calcified fibroid was incidental Cystograms showed that the calcified mass had no relation to the bladder

C —Appearance characteristic of a calcified tuberculous abscess The patient, a boy of 14, had a destructive lesion at the lumbosacral junction which had the appearance typical of tuberculosis The tuberculin reaction also was positive

D —An opaque cystogram showing a rough trabeculated bladder which appears elevated by a large prostate On the left side are three rings of calcium which proved to be calcification around the masses of a paraffinoma The patient, a man of 79, was seen because of hyperplasia of the prostate He gave a history of having had a left inguinal hernia treated by the injection of paraffin several years before Transurethral prostatic resection was done, and pathologic diagnosis was hyperplasia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VESICAL CHANGES WITH CHRONIC OBSTRUCTION Benign hyperplasia of the prostate is the most frequent cause of chronic obstruction of the vesical neck Other causes are carcinoma of the prostate, median bar, stricture, congenital valves and contractures and neurogenic dysfunction With chronic obstruction, the first radiographic change is a slight irregularity of the vesical wall due to the trabeculations, which are a direct result of hypertrophy of the longitudinal and circular muscles The bladder frequently elongates in its superior-inferior diameter and becomes conical As obstruction advances, cellules develop between the longitudinal and circular fibers of the vesical musculature In obstruction of the vesical neck, the difference between a cellule and a definite diverticulum is apparently only a matter of degree However, the development of diverticula in cases of benign hyperplasia or carcinoma of the prostate occurs in only 9 per cent of the cases This leads one to suspect that there may be a congenital basis for the development of diverticula arising in conjunction with chronic obstruction of the neck of the bladder It is true that very rarely diverticula appear to develop in an anomalous ureteral bud or in a patent urachus These, however, cannot possibly account for all diverticula The posterior vesical wall is the most common site for diverticula The next most frequent location is on either side of the bladder close to the ureteral orifices, and in this situation a diverticulum may produce symptoms from obstruction of the ureter The anterosuperior wall is the next most common site

Other locations are less common, and the fundus of the bladder is rarely involved Diverticula are best demonstrated radiographically by means of air and opaque cystograms While most of them will be revealed in an anteroposterior view, it may be necessary to obtain views in the right or left oblique positions

When the size of the diverticulum approaches that of the bladder, it can usually be identified by the fact that it has smooth walls, whereas the bladder in chronic obstruction usually shows rough trabeculations It may be necessary, however, to obtain a film after the patient has urinated or has been catheterized The bladder will then be empty, whereas the diverticulum will

remain filled and of the approximate size observed before the bladder was emptied. Occasionally the neck of the diverticulum may be too small to permit visualization or the diverticulum may be filled with tumor or debris which prevents its filling with the opaque medium. In this event a diverticulum can frequently be suspected because it will produce a pressure defect on and perhaps even a displacement of the bladder Stones are not infrequently found in diverticula Neoplasm in a diverticulum however is exceedingly rare Obstruction of the vesical neck in some patients produces dilatation of the ureters, with reflux and perhaps even dilatation of the renal pelvis and calices rather than vesical diverticula or both conditions may occur together Why reflux should develop in some patients and diverticula in others is open to speculation.

[Chronic obstruction *continued on page 206*]

TRABECULAE FROM CHRONIC OBSTRUCTION

A —A mildly trabeculated bladder in a man of 65 who had had gonorrhea 35 years before, followed by stricture He had had dilatation of the stricture at irregular intervals since The blood vessels show calcification

B —Slight roughening of the vesical wall, indicating early trabeculation in a man of 71 who had had few symptoms until complete retention developed Transurethral resection was done, and pathologic diagnosis was adenocarcinoma of the prostate

C —Mildly trabeculated bladder in a man of 70 with benign prostatic hyperplasia

D.—Trabeculated bladder with cellules in a patient with benign prostatic hyperplasia There was 240 cc of residual urine

E —Conical bladder with rough trabeculated wall in a man of 69 who had had increasing symptoms of obstruction of the vesical neck for seven years from benign hyperplasia of the prostate There was 400 cc of residual urine With obstruction at the neck of the bladder, it is common for the bladder to become conical, perhaps owing to a urachal extension

F —Rough trabeculated bladder with multiple cellules and small diverticula in a man of 86 who had had urinary difficulty for six years from benign hyperplasia of the prostate There was 250 cc of residual urine


C
D
E
F

TRABECULAE FROM CHRONIC OBSTRUCTION .

A—A mildly trabeculated bladder in a man of 65 who had had gonorrhea 35 years before, followed by stricture He had had dilatation of the stricture at irregular intervals since The blood vessels show calcification

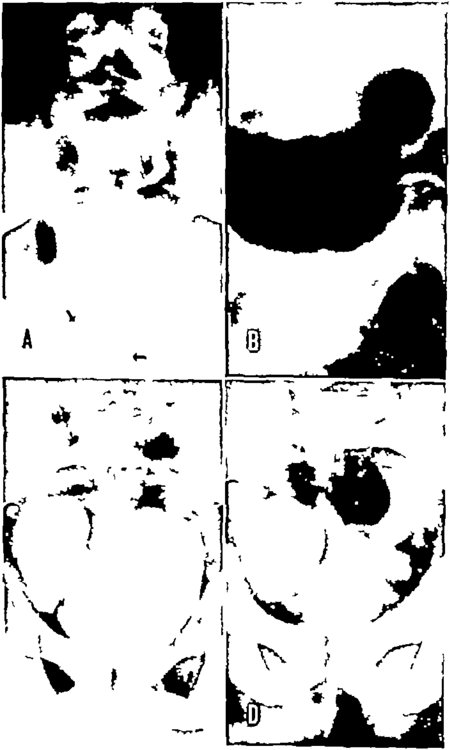
B—Slight roughening of the vesical wall, indicating early trabeculation in a man of 71 who had had few symptoms until complete retention developed Transurethral resection was done, and pathologic diagnosis was adenocarcinoma of the prostate

C—Mildly trabeculated bladder in a man of 70 with benign prostatic hyperplasia

D—Trabeculated bladder with cellules in a patient with benign prostatic hyperplasia There was 240 cc of residual urine

E—Conical bladder with rough trabeculated wall in a man of 69 who had had increasing symptoms of obstruction of the vesical neck for seven years from benign hyperplasia of the prostate There was 400 cc of residual urine With obstruction at the neck of the bladder, it is common for the bladder to become conical, perhaps owing to a urachal extension

F—Rough trabeculated bladder with multiple cellules and small diverticula in a man of 86 who had had urinary difficulty for six years from benign hyperplasia of the prostate There was 250 cc of residual urine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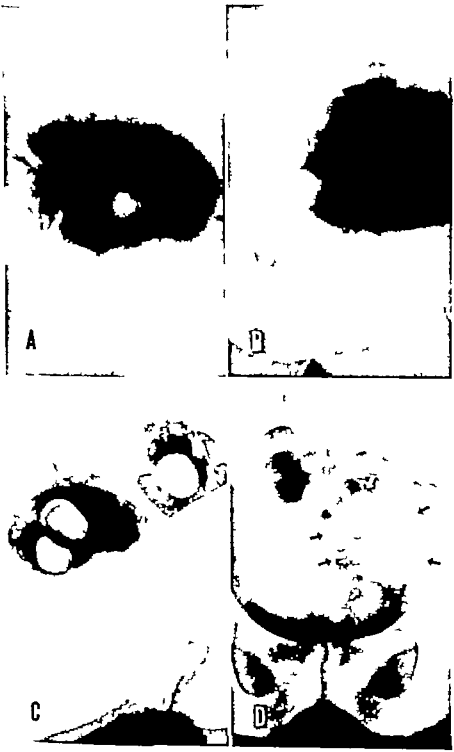
A.—This film of the lower urinary tract, taken following excretory urography and at the end of micturition, shows a large filled diverticulum on the left which displaces the ureter. This illustrates one of the causes of ureterectasis. The bladder is nearly empty and contains only a small amount of the opaque material. The patient was a man of 25 with a fibrotic median bar. A diverticulectomy and transurethral resection of the bar gave a good functional result.

B.—A left oblique air cystogram shows a urachal extension rather than a diverticulum, indicated by its broad neck and location at the vertex of the bladder. The patient, a man of 77, had had difficulty in urinating for only three months. The prostate was hard and fixed on palpation. Six grams of tissue was resected transurethrally. Pathologic diagnosis was adenocarcinoma of the prostate.

C.—This anteroposterior opaque cystogram shows a bladder of normal size with a rough, trabeculated wall and cellules on the left. On the right is a smooth-walled diverticulum causing characteristic pressure deformity and displacement of the bladder.

D.—This cystogram of the same patient was taken immediately following micturition. The bladder has almost completely emptied, whereas the diverticulum is filled to about the same extent as previously. The narrow neck between the bladder and diverticulum is well demonstrated. The patient, a man of 66, complained of burning and smarting for one year, with difficulty in starting the stream. Sometimes the stream was full and again merely a dribble. Cystoscopic examination demonstrated the opening of the large diverticulum on the right side. A moderate benign enlargement of the prostate was resected.

[Diverticula *continued on page 212*.]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CALCULI IN DIVERTICULA *A*—Right oblique air cystogram demonstrating a calculus in the center of the vesical area

B—A left oblique air cystogram of the same patient, showing the calculus projecting beyond the air-filled bladder, thus indicating that it must be in a diverticulum This graphically illustrates the necessity of obtaining an unobstructed view of the diverticulum to ascertain the location of a calculus This patient, aged 76, first had symptoms of prostatism 10 years before When first seen five years later, seven or eight vesical stones were crushed and a hyperplastic prostate was resected transurethrally Two months before, he had recurrence of symptoms A stone found in the bladder was crushed, but the stone observed in the diverticulum was not reached

C—Right oblique air cystogram demonstrating two typical calculi in the bladder A small filling defect due to hyperplasia of the prostate is seen in the bladder A diverticulum posteriorly containing a single calculus is outlined with air The patient, a man of 73, had had little urinary difficulty until complete retention followed an abdominal operation two months before There was 1,000 cc of residual urine A diverticulectomy was done and a stone removed

NEOPLASM IN A DIVERTICULUM *D*—Anteroposterior opaque cystogram The bladder is of about normal size, shows little trabeculation of the wall, but there is a pressure defect on the left side due to a diverticulum This is faintly outlined by the opaque medium which has infiltrated into the interstices of a tumor which fills it Cystoscopically, necrotic, friable tissue was seen projecting from the diverticulum This had the appearance of a transitional cell carcinoma The patient, a man of 74, had had hematuria for one year


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TUMORS The pathologic classification of tumors of the bladder is still in a state of confusion Radiographically, like tumors of the renal pelvis, they fall into two groups the papillary, and the sessile Further radiographic differentiation is not feasible The value of roentgen rays in the diagnosis of tumors of the bladder is mainly in establishing their presence and determining their size, location and general configuration The only radiographic indication of the malignancy of a vesical tumor is detection of metastases to other organs, particularly the lungs and bones

Vesical tumors may occasionally be demonstrated on opaque cystograms It is not uncommon, however, for a tumor to be completely obscured by the dense medium of an opaque cystogram, and unless the tumor is observed tangentially, it may be entirely overlooked Visualization of the bladder following excretory urograms occasionally reveals the filling defect of a tumor, and certainly in every excretory urogram the bladder should be carefully inspected with this possibility in mind Since the density of the visualized bladder is not as great in excretory urography, vesical filling defects are likely to be better demonstrated than in the sodium iodide cystograms Air cystograms, however, offer by far the greatest opportunity for visualization of a tumor, as the tumor stands out in striking relief against an air-filled bladder Small vesical tumors usually cannot be demonstrated radiographically, and no tumor can be shown unless it is surrounded by a contrast substance or is calcified In air cystograms a tumor located dependently in a partially emptied bladder will not be visualized if covered by urine, even though the bladder appears to be well outlined by air This is because there is no contrast in density between the tumor and the urine For this reason it is important to empty the bladder completely before doing air cystography or to obtain views in more than one position to bring a suspected lesion away from the dependent urine-containing portion of the bladder The polypoid tumors are most common, comprising well over 90 per cent of vesical tumors The sessile, and less common, tumors are detected by the flattening and apparent rigidity of the infiltrated vesical wall Calcifica

tion may occur on the surface of a tumor This can be seen on the plain film or on the air cystogram but opaque cystograms will completely obscure the calcification

In the routine roentgenographic study of tumors of the bladder the minimum requirements are (1) a plain anteroposterior film of the vesical area, (2) an opaque cystogram and (3) an air cystogram. At times additional views may be indicated.

As previously mentioned, primary tumors of the renal pelvis frequently metastasize to the bladder and are implanted on the vesical wall. These secondary tumors cannot be differentiated from primary tumors of the bladder except by the demonstration of a tumor of the kidney in which case any tumor in the bladder is more likely to be an implant.

[Tumors *continued on page 316*]

TUMORS The pathologic classification of tumors of the bladder is still in a state of confusion Radiographically, like tumors of the renal pelvis, they fall into two groups the papillary, and the sessile Further radiographic differentiation is not feasible The value of roentgen rays in the diagnosis of tumors of the bladder is mainly in establishing their presence and determining their size, location and general configuration The only radiographic indication of the malignancy of a vesical tumor is detection of metastases to other organs, particularly the lungs and bones

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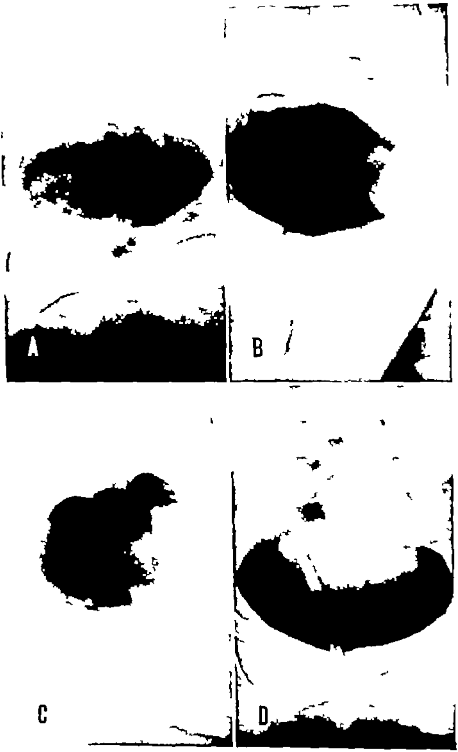
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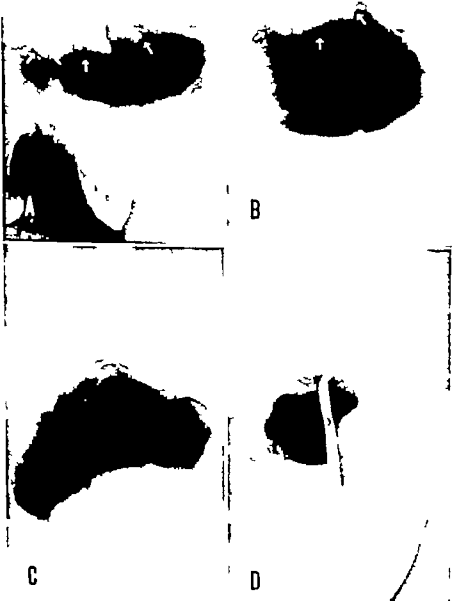
IMPLANT OF TUMOR OF RENAL PELVIS *A*—An anteroposterior air cystogram demonstrating a large filling defect in the right lower quadrant of the bladder The polypoid nature is apparent The patient, a woman of 69, complained of a mass in the right flank Excretory pyelograms did not visualize the right kidney Stones were present, however The left kidney appeared essentially normal The vesical tumor was observed in the excretory cystograms On exploration, a right calculous pyonephrosis was found, nine stones were removed and 400—500 cc of foul-smelling pus and necrotic material evacuated Pathologic diagnosis was papillary type of transitional cell carcinoma of the right renal pelvis The vesical tumor was resected later, and pathologic diagnosis was transitional cell tumor

B—Right oblique air cystogram demonstrating a papillary tumor of the posterolateral wall of the bladder The patient, a man of 75, had hematuria off and on for 18 months On admission, he was having severe hemorrhages from the bladder The tumor was resected and several blood transfusions were given, but he died Autopsy showed the right renal pelvis filled with a neoplasm attached by a small pedicle Pathologic diagnosis of the vesical tumor was transitional cell carcinoma, probably arising in the right renal pelvis and implanted in the ureter and bladder

PRIMARY TUMORS *C*—Right oblique air cystogram demonstrating an irregular filling defect, located posteriorly The patient, a man of 71, had gradually increasing frequency for a year, with hematuria off and on for three months Transurethral resection was done, and pathologic diagnosis was transitional cell carcinoma of the bladder

D—Anteroposterior air cystogram showing a large tumor in the dome of the bladder, confirmed cystoscopically The patient, a woman of 67, with gross hematuria for two months, refused treatment

[Tumors *continued on page 218*]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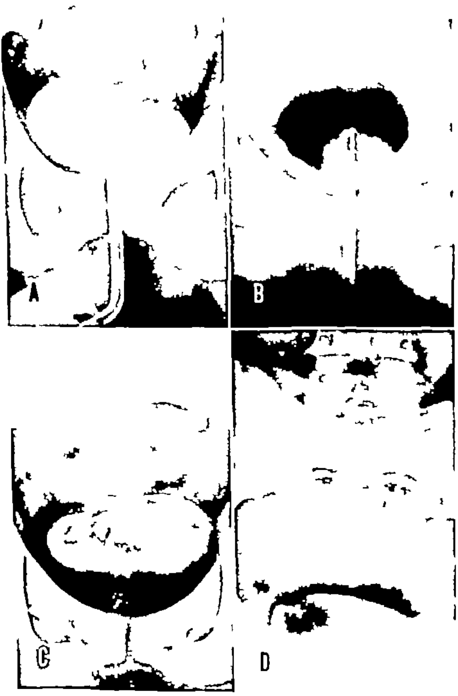
A.—Right oblique air cystogram demonstrating flattening of the dome of the bladder by a large sessile tumor. Cystoscopy confirmed this finding. The tumor was resected transurethrally, and pathologic diagnosis was carcinoma showing glandular structure.

B.—Right oblique cystogram showing a similar filling defect in the dome of the bladder. The tumor seems smooth but gives the appearance of rigidity to the vesical wall. The patient, a man of 63, had a poker spine with a kyphos and arthritis involving the shoulders and both hips. Cystoscopy was not practical, and diagnosis was made from films alone. Irradiation caused marked improvement in the symptoms and in the appearance of the tumor, as shown by cystograms. He was seen a year later with recurrence of symptoms, but supportive treatment was unsuccessful and he died of uremia.

C.—Anteroposterior air cystogram demonstrating a large irregular filling defect involving the trigone and fundus of the bladder, but located slightly more to the left. Cystoscopic examination showed a large, flat vesical tumor with a broad base and overlying necrotic mucosa. The tumor was resected transurethrally, and microscopic section showed epithelial neoplasm of two cell types: papillary formations of transitional epithelium, and squamous epithelial cells with typical prickle cells, whorls and pearls. Pathologic diagnosis was papillary carcinoma of the bladder with squamous metaplasia.

D.—Oblique air cystogram demonstrating a filling defect on the left side of the bladder posteriorly. The patient, a man of 80, had progressively increasing hematuria nine months before admission. Transurethral resection was done, and pathologic diagnosis was papillary carcinoma of the bladder.

[Tumors *continued on page 220*.]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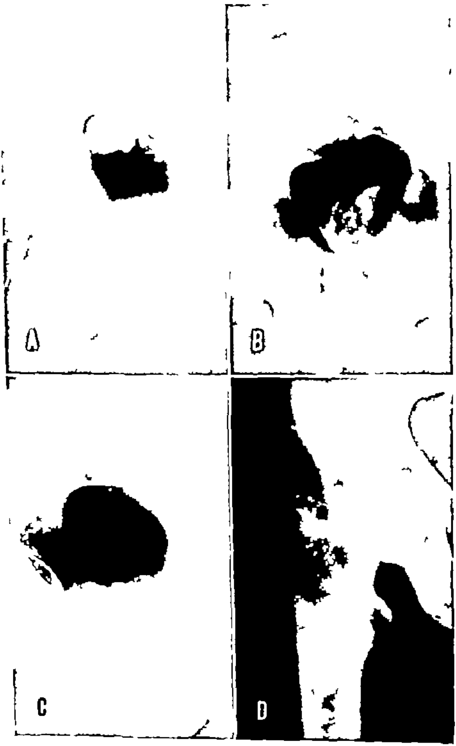
A.—Opaque anteroposterior cystogram showing flattening of the left half of the dome of the bladder. The patient, a man aged 34, had had pyuria for many years. A suprapubic resection showed "a mixed cell type of carcinoma, forming nests of transitional epithelium with cystic degeneration and gland-like structures. Origin from the urachus must be considered." The patient died nine months later, and autopsy showed extensive neoplasm of the same type in the remaining portion of the bladder.

B.—Air cystogram showing a rough trabeculated bladder with a tumor at the vesical neck. The patient, a woman of 68, had been unable to void for four weeks. Cystoscopy showed the tumor almost completely encircling the internal urethral orifice. Transurethral resection was done, and pathologic diagnosis was papillary carcinoma of the bladder.

C.—Visualization of the bladder following excretory urograms. An irregular filling defect almost completely occupies the bladder in its collapsed state. The patient, a man aged 61, had had hematuria for four months. The physical examination was negative. Excretory urograms showed good function of both kidneys. The tumor was resected transurethrally. Pathologic diagnosis was transitional cell carcinoma of the bladder of the papillary type. This film also shows some blood clots in the bladder.

D.—Visualization of the bladder following excretory urograms. The pyelograms appeared negative, but the rounded filling defect of a tumor was observed in the bladder. A pedunculated tumor seen cystoscopically was resected. Pathologic diagnosis was transitional cell carcinoma of the bladder.

[Tumors *continued on page 222*.]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INCRUSTED TUMORS *A.*—Oblique cystograms showing a filling defect in the vertex with deposition of calcium at the periphery. For six months the patient, a man of 61, had often passed blood. Cystoscopy showed a tumor in the dome with so much calcium impregnation that it looked like a stone. The tumor was resected to the level of the vesical wall, and pathologic diagnosis was degenerated carcinoma of the bladder, probably papillary. The patient died eight months later of pneumonia, and autopsy showed no evidence of recurrence.

B.—Oblique air cystogram showing a tumor arising from the trigone, with definite deposition of calcium on the surface, also demonstrated on the plain film. The patient, a man of 65, had had intermittent hematuria for two years. Cystoscopy showed a large tumor deeply infiltrated with calcium occupying the entire trigone and extending up the left side. Resection was difficult because of the calcium. Pathologic diagnosis was undifferentiated carcinoma.

C.—Air cystogram showing an irregular filling defect in the base of the bladder due to a tumor. The patient, a man of 74, began having hematuria and passage of blood clots four years before and since then had had a tumor resected several times. He complained bitterly of pain in the right hip and had lost a great deal of weight. Films of the lungs and right femur showed metastases.

D.—Right femur of the same patient demonstrating a large area of bony destruction in the region of the greater trochanter and a second smaller lesion below the lesser trochanter. There is no evidence of regeneration or reaction. Autopsy showed an infiltrating transitional cell carcinoma of the bladder. The upper right femur showed a pathologic fracture due to metastasis.

[Tumors *continued on page 224*.]


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A—Oblique air cystogram with well delineated, broad-based tumor on the antero-inferior wall The patient was a man of 73 with hematuria for nine months Transurethral resection was done, and pathologic diagnosis was poorly differentiated carcinoma of the bladder

FILLING DEFECTS SIMULATING TUMORS As previously shown, foreign bodies, such as surgical sponges, can produce filling defects indistinguishable from vesical tumors Particularly is this true when they have eroded through the wall of the bladder Soft stones, blood clots, carcinoma of the prostate and feces in the rectum may also produce shadows simulating tumors of the bladder

B—Anteroposterior opaque cystogram showing a large, irregular filling defect involving the entire right half of the bladder from base to vertex The prostate of this patient, a man of 71, was moderately enlarged, nodular and hard Cystoscopic examination showed a large, sloughing prostate which extended well into the bladder along the lateral wall Some tissue was resected to relieve the obstruction at the vesical neck Pathologic diagnosis was adenocarcinoma of the prostate

C—Oblique opaque cystogram showing huge filling defect in the upper portion of the bladder A suprapubic cystotomy showed this defect to be due to a large soft blood clot covering a sessile tumor 4 cm in diameter which had invaded the entire thickness of the vesical wall Pathologic diagnosis was papillary carcinoma

D—Oblique air cystogram with the bladder displaced forward by a mass of feces in the rectum which is outlined by gas The finely granular appearance of impacted feces is in itself typical, but when surrounded by air and superimposed over an air-filled bladder, the appearance may strongly suggest a tumor of the bladder

The Urethra

THE POSTERIOR OR PROSTATIC URETHRA

Roentgen examination offers valuable information in the study of diseases of the urethra and adjacent structures. This is particularly true of diseases of the prostate. Since the normal prostate is of the same density as the surrounding tissues, it is invisible on radiographs. Calculi either in the prostatic urethra or in the prostatic tissue and characteristic bony metastasis from carcinoma of the prostate are the only conditions that can be diagnosed from the plain film. It is well known from the study of anatomic and surgical material that certain diseases deform the prostate and urethra in a definite and characteristic manner (Wilson and McGrath, Randall, etc.). These deformities can often be demonstrated radiographically by filling the bladder and the posterior urethra with contrast substances. Air is preferred as a contrast medium in the bladder since it allows visualization of the vesical neck and therefore any deformity which results from prostatic distortion or enlargement. Because the urethra passes through the prostate, most of the diseases of the prostate produce a deformity or a change in the appearance of the prostatic urethra which is visible on the film when the urethra is filled with an opaque medium. These deformities are frequently characteristic of certain prostatic lesions. Abscesses of the prostate may communicate directly with the urethra and thus be visualized on the cysto-urethrogram. In this way also prostatitis, benign prostatic hyperplasia and carcinoma are likely to deform the prostatic urethra, and this, with the appearance of the vesical neck, frequently gives valuable information regarding the type of prostatic disease.

While cysto-urethrography does not replace cystoscopy and urethroscopy, it is a valuable adjunct because it provides a permanent record and often gives information not obtained in any other way. As will be seen later, there are many instances in which there is a definite advantage in combining the roentgen examination of the urethra with that of the bladder.

Cysto-urethrography is easily performed from both the patient's and the operator's standpoint, and it is no more dangerous than cystoscopy.

while the opaque jelly is being injected through the posterior urethra this is imperative for visualization of the posterior urethra.

THE NORMAL URETHRA Observed in the oblique projection the prostatic portion or posterior urethra extends from the internal urethral orifice through the prostate gland to the membranous portion or external sphincter a distance of 3–4 cm depending somewhat on the age and size of the individual The anterior border of the prostatic urethra is gently curved with the convexity posterior

The posterior border of the prostatic urethra is more angular with the apex of the angle directed backward. At this point there is usually a small filling defect caused by the verumontanum. This is also the greatest anteroposterior diameter of the prostatic urethra and is at a level about midway between the internal and the external sphincter Since the inferior portion of the bladder is smooth as observed in the air cystogram and the opaque jelly is usually injected in excess this excess runs down the wall of the bladder to the most dependent portion where it forms a pool Because of the viscosity of the jelly this collection may be irregular and must not be interpreted as a filling defect produced by a lesion in the bladder Likewise one must be careful not to interpret the stream of opaque jelly as it flows over the vesical wall as being still within the prostatic urethra This is a mistake that has frequently been made as a review of the earlier literature will attest. The distal boundary of the prostatic urethra is formed by the membranous urethra around which is the external sphincter This is the narrowest and least distensible portion of the urethra. It is about 1.5 cm in length in the adult and divides the prostatic from the cavernous or anterior urethra

[Normal urethra *continued on page* 3]

The procedure used at present is the end-result of a long series of developments in technic which may be listed briefly as follows

1 The opaque cystogram employed in cadavers by Zeissl and Holzknecht in 1902 and in living subjects by Wulff in 1905

2 The air cystogram used by Keller of Vienna, described by him in 1904 and successfully used to demonstrate diverticula of the bladder

3 The opaque anterior urethrogram used in the diagnosis of stricture and reported by Cunningham in 1910

4 The satisfactory posterior urethrogram described by Haudek in 1921 It was pointed out by Haudek that the posterior urethra cannot be satisfactorily visualized without making the exposure during the time the opaque medium is being injected If the injection is stopped, the muscle around the posterior urethra approximates the walls and thus empties the lumen

5 The procedure using the dorsal decubitus position, with the patient turned at a 45 degree angle with the horizontal for the study of the posterior urethra, described by Béclère and Henry in 1922

6 The introduction of radiopaque, nonirritating fluid (lipiodol) by Sicard and Forestier in 1924

7 The substitution of a lipiodol jelly for the liquid previously used and the use of air cystograms in combination with the lipiodol jelly urethrograms, reported by Flocks in 1933

The method used in our hospital was developed by Dr Rubin H Flocks It is a culmination of previous contributions plus his innovation, already noted, of the use of a combination of an air cystogram and a urethrogram made with an opaque jelly instead of the liquid medium The procedure has been used well over 10,000 times It consists of (1) a single anteroposterior film of the urinary tract, (2) an anteroposterior sodium iodide cystogram with the patient in a dorsal decubitus position, (3) a right posterior oblique air cystogram with the patient placed at a 45 degree angle with the horizontal, (4) a cystourethrogram taken in the same position For this fourth film, the bladder is still filled with air and the exposure is made


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A —Normal cysto-urethrogram of a boy aged 13 The prostatic urethra is very short, and the impression caused by the verumontanum is plainly seen There is no filling defect at the vesical neck, although considerable opaque jelly has passed into the bladder and now lies in the most dependent portion

B —Normal cysto-urethrogram showing the angular contour of the posterior wall of the prostatic urethra and the distinct impression of the verumontanum The patient was a man aged 42 with diabetes but with no clinical evidence of prostatic disease

C —Normal urethrogram of a man of 70 who had had resection of the rectum and sigmoid for carcinoma three years before At that time, a diagnosis of a stone in the lower end of the left ureter was made, the prostate was not enlarged At the time of this examination the patient had no urinary symptoms

D —Urethrogram of a man aged 66 showing slight prostatic enlargement with concretions The bladder is smooth and shows no trabeculations


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CONGENITAL ANOMALIES Epispadias and bifurcation of the clitoris are closely related to exstrophy of the bladder, in that they are all different degrees of the same maldevelopment of the lower urinary tract All are readily observed by direct inspection They are, however, frequently accompanied by malformations of the pelvis which are of interest from the radiographic standpoint These changes include poorly developed pubic bones with wide separation of the symphysis pubis The wings of the ilia are rotated outward, producing a broad, flat pelvis The maldevelopment of the pelvis may be of the same degree in complete exstrophy, epispadias or bifurcation of the clitoris, so that from the plain film of the pelvis it is impossible to tell which of the accompanying soft tissue anomalies is present These patients frequently complain of backache due to the undue strain on the sacro-iliac joints

A —Widely separated symphysis, with poorly developed pubic bones in a girl aged 18 with epispadias She had been seen first at the age of 5 years because of incontinence and dribbling A plastic operation had given her fair control of vesical function for 12 years At this time, hematuria had developed and inflammatory polyps were found inside the neck of the bladder Following the fulguration of the polyps, the patient had complete loss of urinary control and ureteral transplants were necessary

B —Film of the pelvis showing changes similar to those in the foregoing case The patient, a woman of 44, complained of pain in the back The only accompanying urinary tract anomalies were a bifid clitoris and an ectopic kidney It is interesting to note that this patient had been delivered of a normal child 15 years before

CONGENITAL CONTRACTURE OF THE VESICAL NECK This anomaly, demonstrable radiographically by cystography or urethrography, is characterized by a narrow band of tissue at the internal urethral orifice usually accompanied by signs of lower urinary tract obstruction, such as a large dilated bladder, ureterectasis and hydronephrosis The prostatic urethra distal to the obstruction is wide and gaping and accompanying infection is common

A —Opaque cystogram of a boy of 2 months showing the encircling band of tissue at the internal urethral orifice, dilated prostatic urethra and bladder and reflux up the right ureter At autopsy, a band was found at the internal urethral orifice

B —Cystogram of a boy of 3 showing a similar contracture at the vesical neck, dilated prostatic urethra, large trabeculated bladder, left ureterectasis and hydronephrosis A suprapubic cystotomy was done first, then the posterior lip of the internal urethral orifice was resected Four months later function was good and there was no residual urine

CONGENITAL FISTULA Congenital malformations associated with imperforate anus occur about once in 5,000 births, according to Keith The rectum is likely to communicate with the urethra in the male or with the vagina in the female

C —Film taken after injection of lipiodol into the urethra showing a communication with the rectum arising from the membranous portion and projecting backward and upward to the bowel The patient, a boy of 5, was born with an imperforate anus

TRAUMATIC FISTULA *D* —Urethrogram showing traumatic rupture of the prostatic urethra, with extravasation through a perineal fistula both externally and into the retro vesical space The patient, a boy of 11, fell on a sharp stick which had penetrated the perineum and ruptured the prostatic urethra


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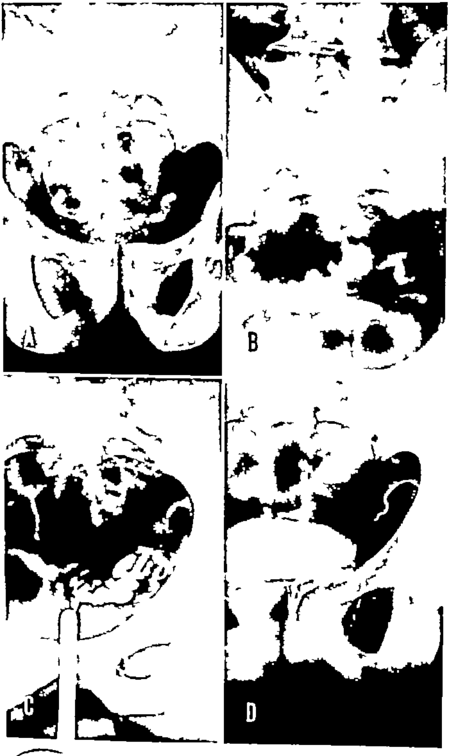
SEMINAL VESICLES. These are not normally visualized on films of the urinary tract. Rarely, however, they become calcified and are rendered visible on the radiograph; usually the ducti deferentia are also calcified. Calcification is usually bilateral, and the structures are readily recognized by their characteristic position, shape and course. The seminal vesicles lie just above the upper border of the pubic bone and extend upward and lateral, as a series of serpiginous tubules. The ducti deferentia lie above the seminal vesicles, turn lateral, upward and forward, then swing downward to the testicles. At the fundus of the bladder, each ductus is enlarged and tortuous; this portion is termed the ampulla. The seminal vesicles and ducti deferentia may also be visualized by opaque material, either by injection through the ejaculatory duct or by introducing a needle into a ductus deferens.

A.—Single anteroposterior film of the lower urinary tract demonstrating the appearance characteristic of calcification of the seminal vesicles and ampullae of the ducti deferentia. In this man of 71, the calcification was found incidentally and apparently had given no symptoms.

B.—Film showing typical appearance of calcification of the ducti deferentia with a few flecks of calcification in the seminal vesicles immediately beneath. The patient, 64, had no urinary symptoms.

C.—Seminal vesicles and ductus deferens of a man of 25 after the left ejaculatory duct was catheterized and opaque material injected.

D.—Left ductus and seminal vesicle in a man of 21, visualized by injection of opaque material through a needle introduced into the ductus deferens.



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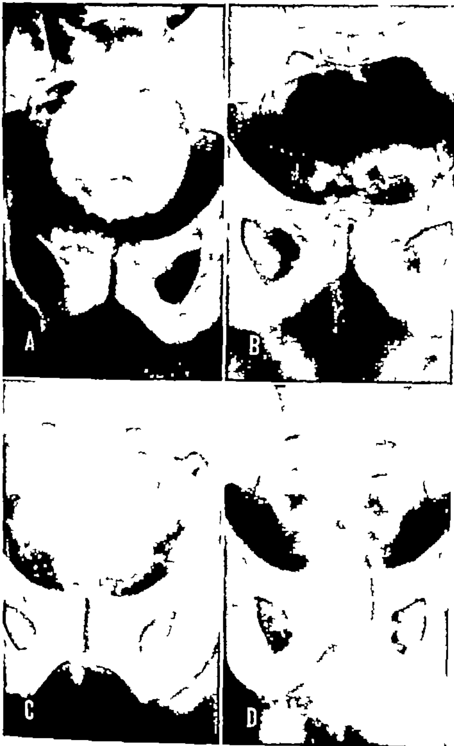
PROSTATIC CALCULI Calcification developing within the prostate is common, and roentgen examination of the pelves of any group of elderly men will reveal many cases The concretions may be distributed rather uniformly throughout the gland or displaced to one side by a hyperplastic lobe They are usually symptomless The calculi are usually small, from 2 to 4 mm in diameter, although occasionally they attain a much larger size The multiple small calcium densities have a fairly typical appearance and of course are always located in the region of the prostate True urinary calculi may also be found in the prostatic urethra, but these usually originate in the bladder and become lodged in the prostatic urethra, although it is possible for them to develop in the urethra itself

A —Opaque cystogram showing a prostatic filling defect in the bladder, with the prostate fairly well outlined by numerous concretions having a typical appearance On transurethral resection, many pockets with prostatic calculi were encountered Over 150 were recovered and probably as many more were washed out

B —Several small calculi and one large one in the prostate of a man of 60 During transurethral resection for benign hyperplasia, a pocket was encountered posteriorly which contained the calculi illustrated The large calculus measured 2 cm in diameter

C —Small collection of prostatic calculi just to the left of the symphysis pubis, location and appearance are characteristic The patient, 76, complained of abdominal pain unrelated to the urinary tract

D —Large laminated urinary calculus in the prostatic urethra, apparently having come from the bladder At operation, the stone was found completely within the prostatic urethra between the two sphincters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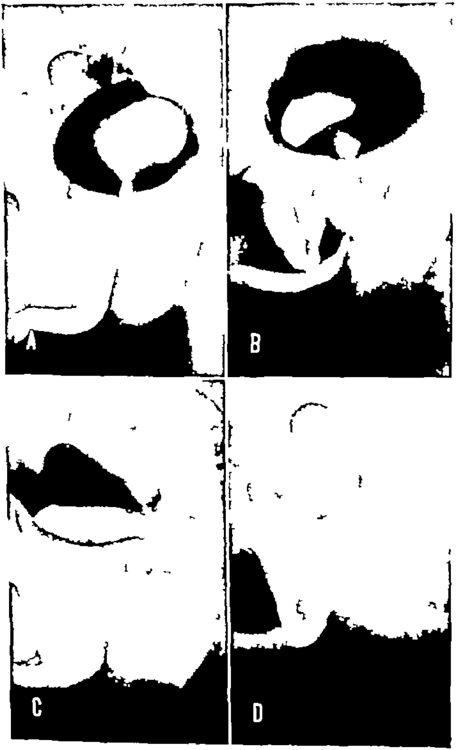
CHRONIC PROSTATITIS . Infection in the prostate is a contraindication of cysto-urethrography, which should be used only in the exceptional case Infection causes swelling of the gland which produces narrowing, straightening and elongation of the prostatic urethra There is usually no visualization of the verumontanum These changes are encountered only with infection and neoplasm, and it may be impossible to differentiate the two conditions radiographically

A —Cysto-urethrogram showing elongation of the prostatic urethra, which is straight It has lost its normal curve and impressions of the verumontanum and the external sphincter The patient, 55, had had increasing urinary frequency with burning and smarting for one year, culminating in complete retention The urine was cloudy and contained great quantities of white and red blood cells The prostate was enlarged, soft and acutely tender An indwelling catheter was kept in for several days while he received hot sitz baths After a week, considerable pus drained away and symptoms subsided

B —Right oblique cysto-urethrogram showing a straight and narrow prostatic urethra The findings are compatible with prostatitis but indistinguishable from carcinoma The patient, 42, complained of marked burning and smarting, foul urine and increased frequency for two years There was residual urine of from 100 to 150 cc Transurethral resection was done, and pathologic diagnosis was chronic prostatitis

C —Cysto-urethrogram of a man of 62 showing elongation and narrowing of the prostatic urethra and loss of impression of the verumontanum Radiographic and clinical diagnosis was carcinoma of the prostate

D —Urethrogram of the same patient 18 months later showing prostatic urethra normal It was therefore concluded that the condition was chronic prostatitis rather than neoplasm, as first supposed The patient died of coronary occlusion at 65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CAVITIES AND ABSCESSES IN THE PROSTATE

The normal glandular structure of the prostate is never visualized following urethrography with opaque jelly. Following chronic infection, particularly gonorrhea, the ducts are dilated and may be visualized. Fistulas from the prostatic urethra and abscesses are visualized when they communicate with the urethra. An acute prostatic abscess will displace the bladder and deform the prostatic urethra.

A.—Right oblique cysto-urethrogram showing little deformity of the prostatic urethra but enlargement of the posterior lip of the internal urethral orifice. There is a cavity in the prostate posterior to the region of the verumontanum, probably the result of an old infection of the glands. The man, 71, gave no history of gonorrhea or other prostatic infection, however. Cystoscopically, the cavity in the prostatic urethra appeared to be lined with epithelium. Prostatic resection was done. Pathologic diagnosis was hyperplasia.

B.—Cysto-urethrogram showing cylindrical narrowing of the anterior urethra typical of old dilated stricture. The glands are largely destroyed, and the remaining cavities and ducts are visualized. This man, 68, had had gonorrhea at 16. Stricture of the urethra developed at 51, and he had been dilating this at intervals of 10 weeks.

C.—Fistulous tract from the prostatic urethra to the retrovesical space. This man, 62, had had a transurethral resection for benign hyperplasia of the prostate eight months previously. Difficulty in voiding recurred and attempts to pass a catheter were unsuccessful and apparently caused the fistula.

D.—Prostatic abscess communicating with the urethra. The bladder is filled with air and displaced upward. The prostate is hyperplastic, as suggested by widening and elongation of the urethra. This man, 65, had complete retention. A suprapubic cystotomy was done and the abscess drained.


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BENIGN HYPERPLASIA OF THE PROSTATE

It is well established that in benign hyperplasia of the prostate there is not a diffuse enlargement of the anatomic lobes but rather a localized hyperplasia of glandular tissue, usually located periurethrally but sometimes also arising in the prostate above the verumontanum This hyperplastic tissue compresses the normal prostatic tissue into a false capsule The so-called "prostatectomy" in the sense in which it is commonly employed is removal not of the entire gland but only of the hyperplastic nodule Likewise, when speaking of an enlarged lobe, it is the hyperplastic nodule that is referred to rather than the anatomic lobe

Simple prostatic hyperplasia, practically speaking, occurs as three pure types, the resulting deformity of the urethra is directly dependent on the type and degree of enlargement The first type, enlargement in both lateral lobes, causes lateral pressure on the urethra, which becomes flattened in its lateral diameter but shows marked increase in its anteroposterior diameter When referring to this phenomenon in descriptions of radiographs, we shall refer to it as "spreading" The urethra also becomes elongated because of the increased superior-inferior diameter of the prostate The second type is posterior commissure or middle lobe hyperplasia The mass of enlarged prostatic tissue produces a sharp anterior displacement of that portion of the urethra which lies just anterior to it This produces an angulation of the prostatic urethra, the apex of which is directed posteriorly in the region of the verumontanum This change we shall refer to later as "anterior tilting" Naturally, this affects the posterior margin of the urethra more than the anterior margin, although the entire urethra from the verumontanum upward may be displaced or tilted forward A third type of hyperplasia involves the subcervical gland of Albarran which, as it enlarges, forms a spherical mass projecting into the bladder above the internal sphincter, which is dilated In pure form, this type of enlargement deforms the prostatic urethra only slightly, but by its position it acts as a ball valve and produces a mechanical block to urination The incidence of the

pure types of prostatic hyperplasia is low however The usual finding is involvement of both lateral lobes and the posterior commissure Occasionally one lateral lobe enlarges more than the other It is common to have either the lateral lobes enlarged more than the posterior commissure or the posterior commissure proportionately larger than the lateral lobes so that actually there is a gradation running from pure lateral lobe enlargement through equal enlargement of all lobes to pure enlargement of the posterior commissure

In pure lateral lobe hyperplasia the bladder is likely to be elevated with the prostatic filling defect either absent or dis proportionately small in comparison with the amount of en largement of the prostate

As pointed out by Randall from the study of anatomic ma terial hyperplasia of the posterior commissure or subcervical gland of Albarran is so situated as to cause early dilatation of the internal sphincter allowing the hyperplastic tissue to protrude into the bladder rather than to cause its elevation In the cysto-urethrogram by judging the distance of the external sphincter from the top of the filling defect or if none is present the distance from the neck of the bladder the size of the hyper plastic prostate can readily be estimated. The character of the enlargement is determined by the contour of the filling defect and deformity of the prostatic urethra Obstruction is largely a mechanical process and the size of the prostate bears no direct relationship to the degree of obstruction that may exist It is not uncommon to have a large prostate with minimal symptoms of obstruction or a small prostate with complete retention

PROSTATIC FILLING DEFECT IN THE BLADDER

When prostatic hyperplastic tissue projects into the bladder, the appearance is usually characteristic and one is frequently able to determine whether the lobes of the prostate have enlarged symmetrically or whether one lobe has enlarged out of proportion to the others

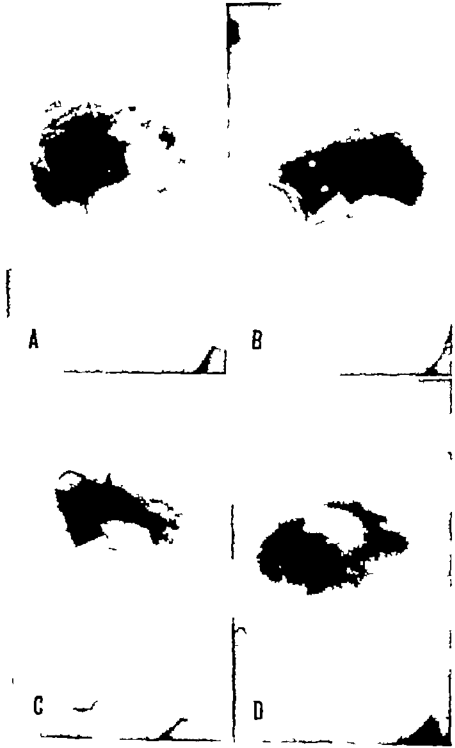
A—Oblique air cystogram demonstrating a large prostatic filling defect in the bladder This appearance is typical of combined hyperplasia of the lateral lobes and posterior commissure, producing the so-called "horse collar" appearance On rectal examination the prostate felt benign Residual urine was 125 cc Transurethral resection was done, and pathologic diagnosis was hyperplasia of the prostate

B—Oblique air cystogram showing a double filling defect in the bladder with each lateral lobe distinct No filling defect can be seen in the region of the posterior commissure Several opaque phleboliths are observed in the pelvic veins On cystoscopy the enlargement was found almost entirely confined to the lateral lobes The posterior commissure was enlarged but to a much less degree Transurethral resection was done, and pathologic diagnosis was hyperplasia

C—Oblique air cystogram demonstrating both lateral lobes and a large posterior commissure All three lobes are distinctly seen The posterior commissure is proportionately larger than the lateral lobes Transurethral resection was done, and pathologic diagnosis was hyperplasia

D—Oblique air cystogram demonstrating filling defect in the bladder from enlargement of both lateral lobes and the posterior commissure The posterior commissure shows greater relative enlargement than do the lateral lobes and produces a sharp anterior tilting of the prostatic urethra which is visualized by the air-filled catheter Transurethral resection was done, and pathologic diagnosis was hyperplasia

[Prostatic filling defect *continued on page 250*]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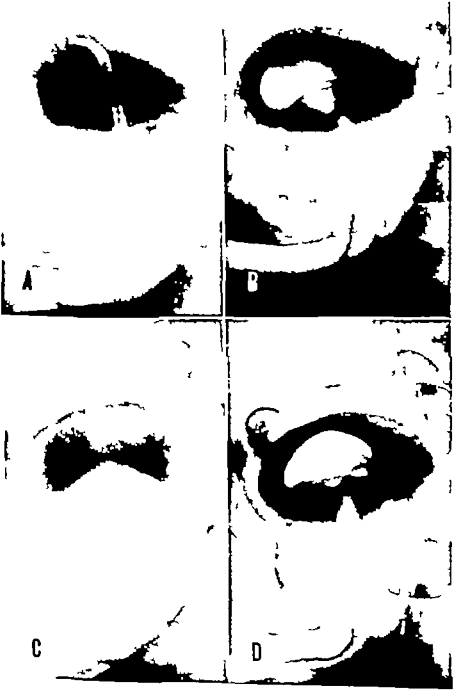
A —Air cystogram demonstrating a smooth filling defect in the bladder, having the appearance characteristic of a benign prostatic hyperplasia involving both lateral lobes and the posterior commissure to about an equal degree The vesical wall is smooth, with little evidence of trabeculation

B —Oblique cysto-urethrogram of same patient Prostatic urethra shows elongation, spreading and sharp anterior tilting The spreading indicates lateral lobe enlargement, and the anterior tilting, displacement from the enlarged posterior commissure The patient, 67, gave a history of moderate difficulty in passing urine for four years He had never had complete retention, and there was no residual urine Rectal examination showed an enlarged benign prostate The symptoms were borderline, so the patient was placed on conservative management He improved considerably on this regimen and was discharged the seventh day

C —Air cystogram showing intravesical protrusion of all three prostatic lobes, which appear to be enlarged to about the same degree, thereby producing the so-called "horse collar" defect in the bladder

D —Cysto-urethrogram of the same patient showing definite elongation of the prostatic urethra with spreading and some anterior tilting, which, however, is not marked The patient, 58, had had episodes of complete retention at varying intervals for a year His most recent was six days before admission, and since that time he had been catheterized daily On admission there was 400 cc of residual urine, but the patient had been able to void spontaneously the day before for the first time Transurethral resection was done, and pathologic diagnosis was hyperplasia

[Prostatic hyperplasia *continued on page 252*]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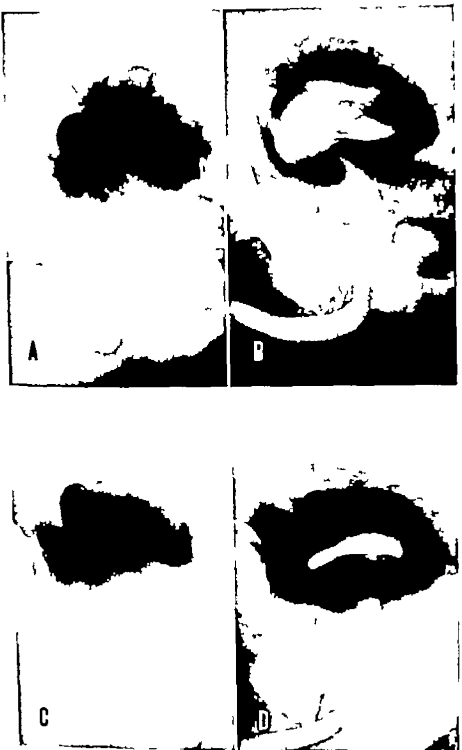
A —An cystogram demonstrating a smooth filling defect in the bladder, having the appearance characteristic of a benign prostatic hyperplasia involving both lateral lobes and the posterior commissure to about an equal degree The vesical wall is smooth, with little evidence of trabeculation

B —Oblique cysto-urethrogram of same patient Prostatic urethra shows elongation, spreading and sharp anterior tilting The spreading indicates lateral lobe enlargement, and the anterior tilting, displacement from the enlarged posterior commissure The patient, 67, gave a history of moderate difficulty in passing urine for four years He had never had complete retention, and there was no residual urine Rectal examination showed an enlarged benign prostate The symptoms were borderline, so the patient was placed on conservative management He improved considerably on this regimen and was discharged the seventh day

C —An cystogram showing intravesical protrusion of all three prostatic lobes, which appear to be enlarged to about the same degree, thereby producing the so-called "horse collar" defect in the bladder

D —Cysto-urethrogram of the same patient showing definite elongation of the prostatic urethra with spreading and some anterior tilting, which, however, is not marked The patient, 58, had had episodes of complete retention at varying intervals for a year His most recent was six days before admission, and since that time he had been catheterized daily On admission there was 400 cc of residual urine, but the patient had been able to void spontaneously the day before for the first time Transurethral resection was done, and pathologic diagnosis was hyperplasia

[Prostatic hyperplasia *continued on page 252*]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A—Air cystogram demonstrating a filling defect in the bladder typical of enlargement of both lateral lobes and the posterior commissure of the prostate

B—Cysto-urethrogram of the same patient demonstrating elongation, spreading and anterior tilting of the prostatic urethra The posterior commissure is enlarged relatively more than are the lateral lobes The patient, aged 72, had had symptoms of vesical neck obstruction for three years and had had complete retention on two occasions There was no residual urine on admission Rectal examination showed moderate prostatic enlargement, but the pathologic diagnosis is not known

C—Air cystogram showing some trabeculation of the vesical wall with a smooth filling defect, apparently due to equal enlargement of the three lobes of the prostate

D—Cysto-urethrogram of the same patient demonstrating that the prostatic enlargement is mainly intravesical There is considerable elongation with much spreading but little anterior tilting, which indicates that the enlargement is mainly of the lateral lobes The patient, aged 73, had had difficulty in passing urine for five years There had recently been marked frequency but no complete retention or hematuria Rectal examination showed moderate benign enlargement of the prostate Transurethral resection was done, and pathologic diagnosis was hyperplasia

[Prostatic hyperplasia *continued on page 254*]


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A.—Oblique air cystogram demonstrating marked intravesical enlargement of the prostate. The posterior commissure shows more enlargement than do the lateral lobes.

B.—Cysto-urethrogram of the same patient showing marked elongation and considerable spreading and anterior tilting of the prostatic urethra. The patient, aged 63, had a history of several episodes of complete retention in two years. There had been diminution in the size and force of the stream with some increased nocturia. On rectal examination, the prostate showed enlargement but felt benign. There was 15 cc. of residual urine. Transurethral resection was done, and pathologic diagnosis was hyperplasia of the prostate. It is interesting to note that some of these large prostates cause little, if any, residual urine.

C.—Oblique air cystogram showing enlargement of all lobes which project into the bladder. The lateral lobes and posterior commissure are enlarged to an equal degree.

D.—Cysto-urethrogram of the same patient demonstrating marked elongation, considerable spreading and moderate anterior tilting of the prostatic urethra, indicating enlargement of the three lobes. The patient, aged 74, complained of frequency, diminished force of the stream, occasional incontinence, constant urgency and passage of only small amounts of urine for two years. The first attack of complete retention had been two weeks before. Transurethral resection was done, and pathologic diagnosis was hyperplasia of the prostate.

[Prostatic hyperplasia *continued on page 256*.]


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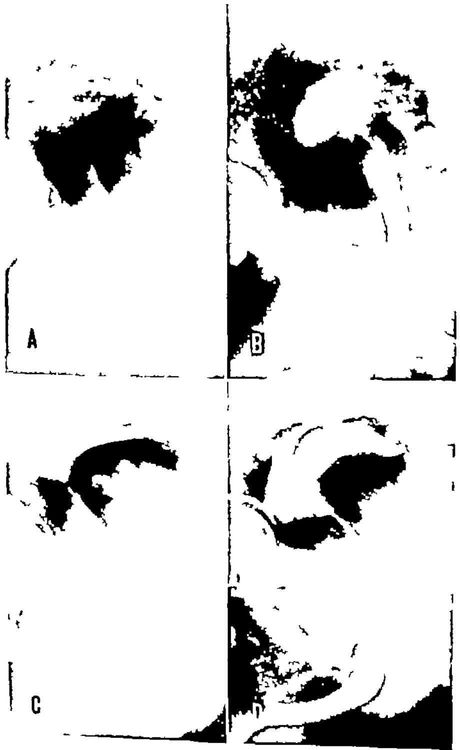
A.—Air cystogram showing a small, smooth filling defect in the bladder. Vesical walls are smooth with no evidence of trabeculation.

B.—Cysto-urethrogram of same patient showing considerable spreading and marked anterior tilting of the prostatic urethra but little elongation. The patient, 66, had had burning, smarting and frequency with nocturia for about four months. There was 100 cc. of residual urine. Cystoscopy showed the posterior commissure projecting forward like a knuckle. The lateral lobes were small and formed a small collar of tissue. The posterior urethra was short and the two lateral lobes bulged into it slightly but did not quite meet in the midline. Transurethral resection was done, and pathologic diagnosis was hyperplasia of the prostate.

C.—Air cystogram showing a small filling defect in the bladder and slight trabeculation of the vesical wall.

D.—Cysto-urethrogram of same patient, 71, showing elongation without spreading or anterior tilting of the prostatic urethra. He gave a history of nocturia and diuria for two or three years, with episodes lasting about a week. There had been frequency with burning and smarting and some difficulty getting the stream started. Physical examination showed mild benign enlargement of the prostate. The patient was also diabetic, but this condition was controlled. He was treated conservatively. No cystoscopic examination was done.

[Prostatic hyperplasia *continued on page 258*.]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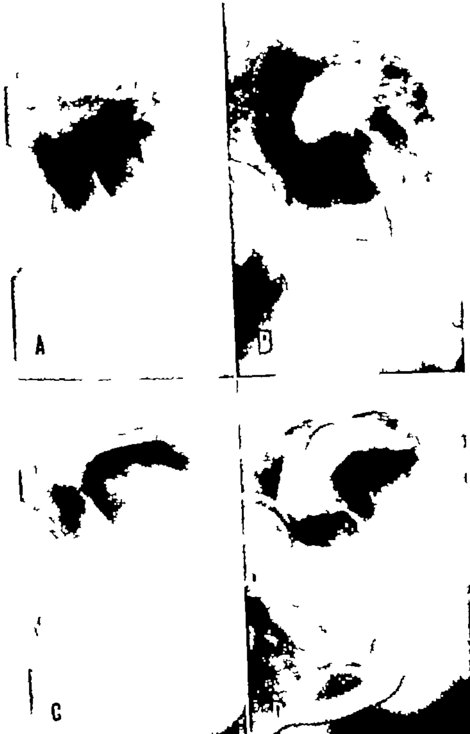
A—Oblique air cystogram showing a large filling defect in the bladder This has the smooth contour and location of benign prostatic hyperplasia

B—Cysto-urethrogram of the same patient demonstrating marked elongation of the prostatic urethra and a moderate amount of spreading but no appreciable amount of anterior tilting The urethra maintains its normal curve This enlargement is mainly of the lateral lobes with a considerable portion of the prostatic enlargement in the bladder The patient, aged 72, had had repeated episodes of complete urinary retention for seven or eight years Rectally the prostate was moderately enlarged but felt benign There was 400 cc of residual urine Three small jackstone calculi in the bladder were crushed and washed out Cystoscopy showed the lateral lobes considerably enlarged and the posterior commissure also somewhat enlarged Transurethral resection was done, and pathologic diagnosis was hyperplasia

C—Oblique air cystogram showing a rounded filling defect characteristic of "horse collar" hyperplasia involving all three lobes The shadow of a large calcified artery is superimposed on the prostatic filling defect

D—Considerable anterior tilting of the prostatic urethra, with spreading and elongation in same patient 80 He had difficulty in starting the stream About three months before he had complete retention and had been hospitalized with an indwelling catheter for three weeks He had been catheterized intermittently since that time Cystoscopy showed all three lobes of the prostate enlarged Transurethral prostatic resection was done

[Prostatic hyperplasia *continued on page 260*]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A —Oblique air cystogram showing enlargement of both lateral lobes and the posterior commissure The lobes are fairly distinct, and the commissure shows greater relative enlargement

B —Cysto-urethrogram of the same patient There is spreading, elongation and anterior tilting of the prostatic urethra The region of the external sphincter is distinctly marked The patient, aged 56, had had symptoms of urinary obstruction for five years Three months previously he had had complete retention and had been catheterized for about six weeks Since then he had been able to void with difficulty Physical examination showed moderate benign enlargement of the prostate Cystoscopy showed enlargement of all three lobes with the posterior commissure entirely intravesical Transurethral resection was done, and pathologic diagnosis was hyperplasia

C —Cysto-urethrogram demonstrating that the prostatic enlargement is mainly intravesical and that there is little deformity of the extravesical portion of the prostatic urethra The patient, 64, had had recurrent difficulty in emptying his bladder There was no residual urine On transurethral resection, 43 5 Gm of tissue was removed Pathologic diagnosis was benign hyperplasia

D —Cysto-urethrogram showing great elongation of the prostatic urethra and elevation of the bladder from prostatic hyperplasia The prostate is greatly enlarged, but the filling defect in the bladder is of only moderate size, with most of the prostatic enlargement outside the bladder The patient, 76, had been catheterizing himself regularly for 15 years On rectal examination the prostate felt only moderately enlarged Ninety-six grams of tissue was resected transurethrally Pathologic diagnosis was benign hyperplasia

[Prostatic hyperplasia *continued on page 262*]


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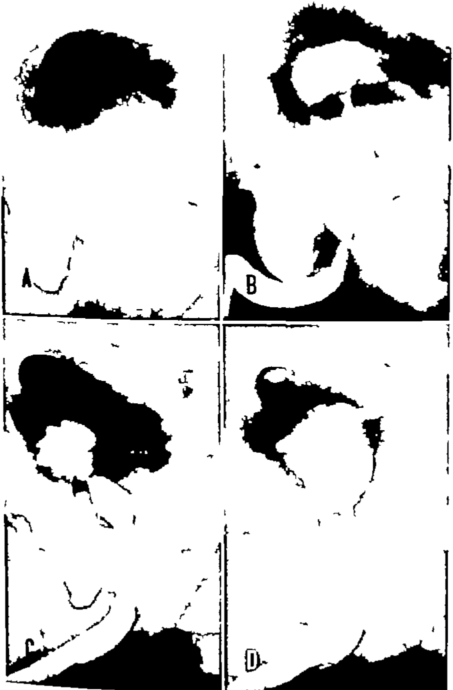
A.—An cystogram showing a filling defect typical of benign hyperplasia. The posterior commissure is enlarged relatively more than the lateral lobes.

B.—Cysto-urethrogram of the same patient demonstrating elongation, slight spreading and moderate anterior tilting of the prostatic urethra. The patient, aged 78, had had symptoms of increasing obstruction of the vesical neck for six months. On admission he was having marked difficulty in urinating and had 200 cc. of residual urine. Rectal examination showed marked benign enlargement of the prostate. Transurethral resection was done, and pathologic diagnosis was hyperplasia.

C.—Oblique cysto-urethrogram showing marked spreading and also elongation and anterior tilting of the prostatic urethra, indicating moderate but equal enlargement of the lateral lobes and the posterior commissure. The patient, aged 79, had been catheterized two weeks previously and 1,000 cc. of urine obtained. Following this he was unable to urinate, so an indwelling catheter was left in place. By rectum, the prostate felt enlarged but benign. Cystoscopically it was fairly large. Thirty-one grams of tissue was removed, and hyperplasia of the prostate was indicated by the pathologic report.

D.—Evidence of removal of considerable prostatic tissue following transurethral resection in the same patient. The prostatic urethra has been straightened, but it still appears irregular and shows filling defects due to tags of tissue. The patient continued to have residual urine, so an additional 20 Gm. of tissue was removed. He still could not urinate well, and residual urine continued to be around 600 cc. Another cysto-urethrogram, however, still showed tags of tissue, so an additional 15 Gm. was removed, making a total of 66 Gm. Following this, the patient was able to urinate with a good stream and empty the bladder completely.

[Prostatic hyperplasia *continued on page 264*.]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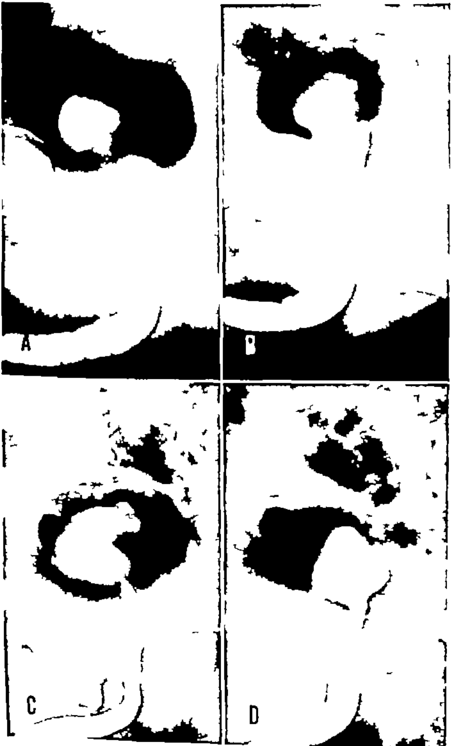
A.—Oblique cysto-urethrogram showing not only a prostatic filling defect in the bladder but also spreading, elongation and anterior tilting of the urethra. These changes indicate benign enlargement of all three lobes.

B.—Cysto-urethrogram of the same patient after transurethral resection, showing a large, smooth defect in the bladder where the prostate has been removed to the external sphincter. The prostatic urethra has been shortened, and there is no longer roentgen evidence of obstruction. The patient, aged 70, had had difficulty in passing urine for 10 or 12 years. This culminated in complete retention one week before admission. Examination showed an enlarged but probably benign prostate. Fifty-five grams of tissue was removed. Pathologic diagnosis was hyperplasia of the prostate.

C.—Oblique cysto-urethrogram showing a small prostatic filling defect. There are some spreading and elongation of the prostatic urethra, with narrowing at the vesical neck. These changes indicate slight benign hyperplasia of the prostate.

D.—Cysto-urethrogram of the same patient following transurethral resection. This shows widening and straightening of the prostatic urethra with no evidence of obstruction. The patient, a Negro of 80, complained of attacks of hematuria for a year. He had had no urinary difficulty. Rectal examination showed benign enlargement of the prostate. The cystoscope was passed with difficulty because of the deformity of the prostatic urethra. All three lobes of the prostate were involved. The lateral lobe enlargement was entirely intra-urethral, while the posterior commissure projected into the bladder. Pathologic diagnosis was hyperplasia of the prostate.

[Prostatic hyperplasia *continued on page 266*.]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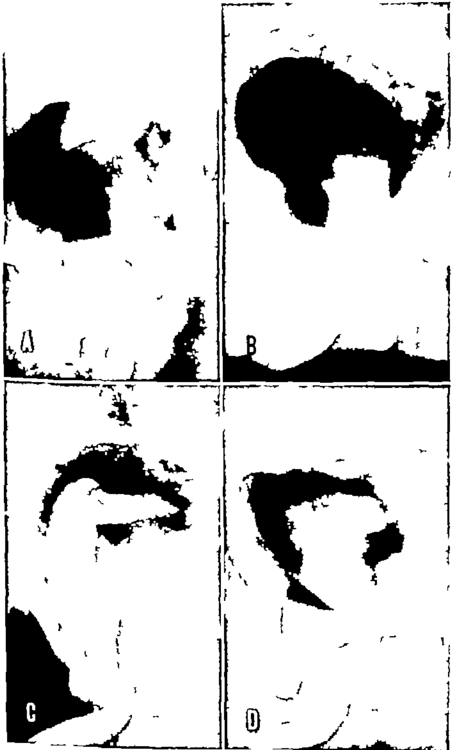
A.—Oblique cysto-urethrogram showing great elongation and extreme spreading but little, if any, anterior tilting of the prostatic urethra There is a huge filling defect in the bladder which is due mainly to enlarged lateral lobes of the prostate The vesical wall shows remarkably little evidence of trabeculation As is often the case, the size of the prostate is no indication of the amount of obstruction present

B.—Cysto-urethrogram of the same patient after the trans urethral resection of 197 Gm of tissue The lumen of the prostatic urethra is now short and shows no obstruction, function was good The patient, aged 78, had had diminution in the size of the urinary stream for one year On rectal examination the prostate felt only slightly enlarged, indicating that the bulk of the hyperplastic tissue in the bladder was not felt There was 100 cc of residual urine Pathologic diagnosis was hyperplasia of the prostate

C.—Oblique cysto-urethrogram showing marked anterior tilting, spreading and elongation of the prostatic urethra and a filling defect in the bladder

D.—Cysto-urethrogram of the same patient following transurethral resection, showing removal of practically all of the prostatic tissue There is some irregularity of the prostatic urethra but no evidence of obstruction The patient, aged 73, was first seen six years before, at which time a diagnosis of benign prostatic hyperplasia was made Resection was recommended but refused Since then he had had intermittent attacks of retention Rectal examination showed moderate benign prostatic enlargement Ninty-five grams of tissue was removed transurethrally Pathologic diagnosis was hyperplasia of the prostate

[Prostatic hyperplasia *continued on page 268*]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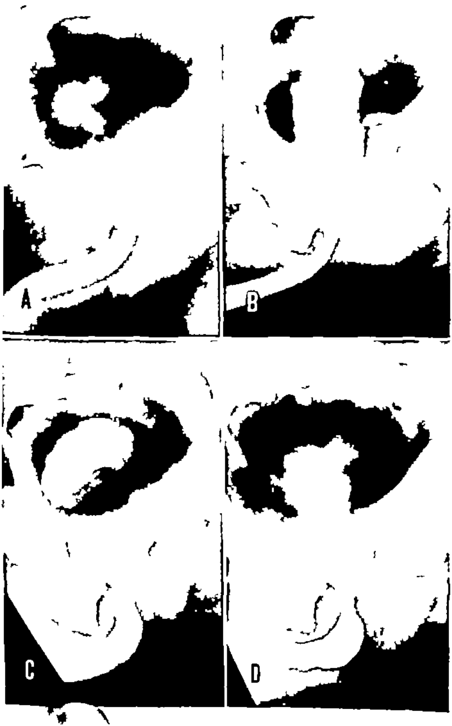
A.—Oblique cysto-urethrogram showing great elongation and extreme spreading but little if any, anterior tilting of the prostatic urethra. There is a huge filling defect in the bladder which is due mainly to enlarged lateral lobes of the prostate. The vesical wall shows remarkably little evidence of trabeculation. As is often the case, the size of the prostate is no indication of the amount of obstruction present.

B.—Cysto-urethrogram of the same patient after the transurethral resection of 197 Gm. of tissue. The lumen of the prostatic urethra is now short and shows no obstruction. function was good. The patient, aged 78, had had diminution in the size of the urinary stream for one year. On rectal examination the prostate felt only slightly enlarged, indicating that the bulk of the hyperplastic tissue in the bladder was not felt. There was 100 cc. of residual urine. Pathologic diagnosis was hyperplasia of the prostate.

C.—Oblique cysto-urethrogram showing marked anterior tilting, spreading and elongation of the prostatic urethra and a filling defect in the bladder.

D.—Cysto-urethrogram of the same patient following transurethral resection, showing removal of practically all of the prostatic tissue. There is some irregularity of the prostatic urethra but no evidence of obstruction. The patient, aged 73, was first seen six years before, at which time a diagnosis of benign prostatic hyperplasia was made. Resection was recommended but refused. Since then he had had intermittent attacks of retention. Rectal examination showed moderate benign prostatic enlargement. Ninety-five grams of tissue was removed transurethrally. Pathologic diagnosis was hyperplasia of the prostate.

[Prostatic hyperplasia *continued on page 268*.]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A.—Oblique cysto-urethrogram showing a filling defect in the bladder. The prostatic urethra shows elongation, anterior tilting and slight spreading. It also appears very narrow in its proximal portion. A film of the pelvis showed lesions characteristic of metastases from carcinoma of the prostate. The patient, aged 74, had had symptoms of obstruction of the lower urinary tract which had become progressively worse. Rectal examination showed slight benign hyperplasia of the prostate.

B.—Cysto-urethrogram of the same patient following transurethral resection and removal of 12 Gm. of tissue. Pathologic diagnosis was benign hyperplasia of the prostate.

It is important to remember that microscopic sections taken from one part of the prostate will not show carcinoma which may be present only in another part of the gland. A film showing bony metastasis is a more reliable criterion for the diagnosis of carcinoma.

C.—Oblique cysto-urethrogram showing a filling defect in the bladder with elongation, slight spreading and anterior tilting of the prostatic urethra. The patient, aged 75, had had complete retention of urine for six days. He had a history of obstruction of the lower urinary tract of about seven years' duration. Rectal examination showed moderate benign enlargement of the prostate. On cystoscopy all lobes of the prostate appeared to be somewhat enlarged. At resection 15 Gm. of tissue was removed. Pathologic diagnosis was hyperplasia of the prostate.

D.—Cysto-urethrogram of same patient after transurethral resection. The lumen is now adequate, and there are no remaining tags of tissue and no evidence of obstruction. At the time of discharge, the patient was able to empty his bladder completely.


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HYPERPLASIA OF THE SUBCERVICAL GLAND OF ALBARRAN *A*—Air cystogram demonstrating a spherical defect in the bladder characteristic of enlarged subcervical gland of Albarran

B—Cysto-urethrogram of the same patient showing slight elongation and spreading of the prostatic urethra, which indicate enlargement also of the lateral lobes The enlarged subcervical gland of Albarran produces a filling defect in the opaque material in the bladder The patient, aged 70, was admitted because of inability to void He had had complete retention 15 years before and intermittent retention requiring some catheterization throughout this period until the present admission Two days before admission he had been unable to pass a catheter, and it was necessary for his physician to do a suprapubic tap On cystoscopy, the enlarged lobe was entirely intravesical and discrete, while the lateral lobes were enlarged only intra-urethrally Transurethral resection was done, and pathologic diagnosis was hyperplasia of the prostate

C—Air cystogram demonstrating a large spherical filling defect in the bladder, with the appearance characteristic of an enlarged subcervical gland of Albarran, and not with the broad base found with hyperplasia of the posterior commissure

D—Cysto urethrogram of the same patient showing some spreading of the prostatic urethra but little evidence of elongation The patient, aged 77, had had symptoms of obstruction of the vesical neck for three years This had been progressive and had terminated 10 days before with complete retention He had been on catheter drainage since that time Rectal examination showed benign prostatic enlargement Cystoscopically, however, the prostate was seen to be much larger than it was thought from the rectal examination and appeared spherical and entirely intravesical The lateral lobes were slightly enlarged Transurethral resection was done, and pathologic diagnosis was hyperplasia

[Gland of Albarran *continued on page 272*]


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A.—This oblique air cystogram shows a spherical filling defect in the bladder characteristic of a subcervical gland of Albarran. While the point of attachment cannot be seen, it is obvious that it does not have the broad base of posterior commissural hyperplasia.

B.—This cysto-urethrogram of the same patient shows little deformity of the prostatic urethra. The impression for the external sphincter is not seen. The patient was a tabetic of 70 with a neurogenic bladder who had had complete retention for two years and had been catheterized twice daily during this period. Cystoscopically, the hyperplastic tissue appeared as a discrete polypoid mass, as indicated by the cystograms. At transurethral resection, 20 Gm. of the enlarged subcervical gland and lateral lobe tissue was removed. *Pathologic diagnosis was hyperplasia of the prostate.*

C.—Cysto-urethrogram of the same patient taken after resection shows no evidence of mechanical obstruction. Because of neurogenic dysfunction, the patient was still unable to void.

SARCOMA OF THE UROGENITAL RIDGE INVADING THE PROSTATE. *D*.—This cysto-urethrogram of a boy of 16 is in no way characteristic, although it does show enlargement of the prostate with narrowing of the urethra at the internal urethral orifice. Complete retention had developed three days before admission. Rectal examination showed a moderately enlarged, fixed, hard and nodular mass in the region of the prostate. Roentgen therapy caused marked diminution in the size of the mass, but metastases developed and he died three months later. Autopsy showed a highly undifferentiated malignant neoplasm arising from the urogenital ridge invading the prostate.


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SUPRAPUBIC PROSTATECTOMY Cysto-urethrography offers a method of studying the prostatic urethra following suprapubic prostatectomy equal in value to that of cystoscopy Following enucleation of the hyperplastic prostatic tissue, a smooth-walled defect remains This defect, however, is smaller than the space occupied by the tissue removed The internal sphincter is always destroyed and remains gaping following prostatectomy, and the appearance of the defect may be identical with that seen following transurethral resection A similar picture may be seen with cord bladders which show a dilated internal sphincter and relaxation of the vesical neck

A —Air cystogram showing a large prostatic filling defect in the bladder from benign hyperplasia of both lateral lobes and the posterior commissure

B —Cysto-urethrogram of the same patient after removal of 129 Gm of tissue by suprapubic prostatectomy

C —Large defect in the neck of the bladder two months after removal of 400 Gm of tissue by suprapubic prostatectomy

D —Cysto-urethrogram showing destruction of the internal sphincter, with a smooth excavation at the neck of the bladder following suprapubic prostatectomy 25 years previously There is no present obstruction, and the patient, aged 87, had done well during this period

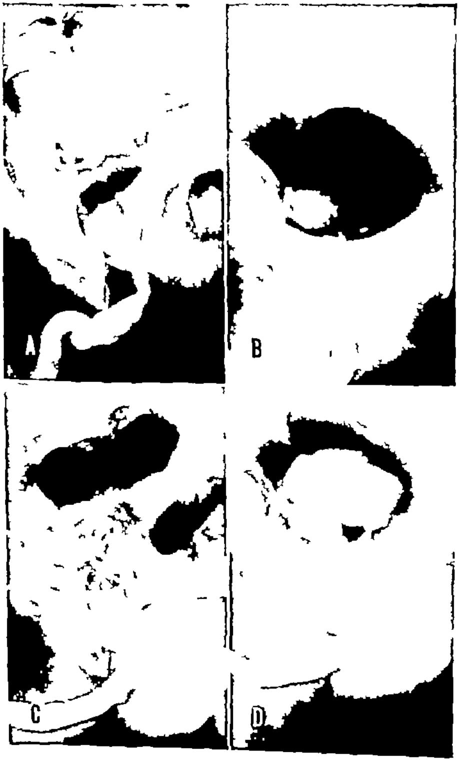
POSTOPERATIVE CONTRACTURE OF THE NECK OF THE BLADDER Very occasionally following either suprapubic prostatectomy or transurethral resection, fibrosis with contracture of the neck of the bladder occurs, with return of obstructive symptoms

E —Contracture of the neck of the bladder following suprapubic prostatectomy Cystoscopy showed a septum separating the bladder from the cavity resulting from the prostatectomy The anterior urethra shows an old inflammatory stricture

F —Cysto-urethrogram showing narrowing at the neck of the bladder eight months after transurethral resection of the prostate for benign hyperplasia

MEDIAN BAR This term has been loosely applied in the past and has been used more or less indiscriminately to cover any condition producing obstruction in the region of the posterior portion of the vesical neck proximal to the verumontanum Randall has made the plea that this term be reserved for that type of bar formation characterized by fibrous rather than glandular or muscular hypertrophy True median bar formation is characterized by lack of enlargement of the prostate and by the formation of a bar or fold of tissue along the posterior surface of the neck of the bladder This produces a "flap valve" effect and leads to signs and symptoms of prostatic obstruction owing to the mechanical closure of this valve on attempts to urinate Median bar is generally believed to be the result of a chronic inflammation with the production of fibrous tissue and a history of chronic gonorrhea is common in patients with this condition There is no filling defect in the bladder but the contracture of the fibrous tissue may produce elevation of the verumontanum so that the anteroposterior diameter of the prostatic urethra at this level is increased. The internal urethral orifice is narrowed and made rigid and is directed forward and upward. The cysto-urethrogram will show extrusion of the opaque jelly into the bladder in a narrow stream like tooth paste from a tube

[Median bar *continued on page 278*]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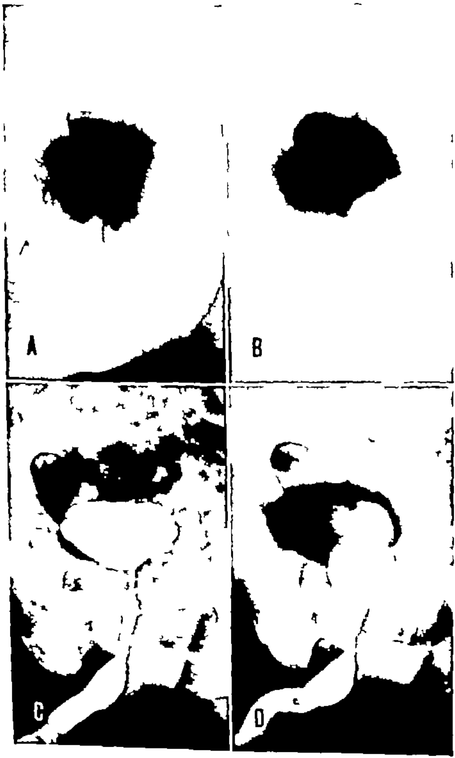
A —Urethrogram showing, at the internal urethral orifice, a fold of tissue which tilts the proximal urethra forward above the verumontanum The verumontanum also appears slightly elevated, so that the anteroposterior diameter of the urethra at this level is increased The excess opaque jelly shows the "tooth paste" effect The patient, aged 25, had had difficulty in voiding for one year The prostate was normal on palpation Transurethral resection was done Histologic study showed a large amount of fibrous tissue and smooth muscle

B —Cysto urethrogram showing no filling defect in the bladder However, the prostatic urethra is tilted sharply forward and narrowed at the vesical neck by a fold of tissue extending from the verumontanum to the internal urethral orifice The latter is narrow, producing the "tooth paste" effect of the opaque jelly The patient, aged 75, had had difficulty with passage of urine for two or three years Rectal examination showed only slight, if any, enlargement of the prostate The patient had had gonorrhea at 20 Cystoscopy showed a considerable pocket below and behind the posterior lip Transurethral resection was done Histologic study showed smooth muscle and fibrous tissue

C —Urethrogram almost an exact duplicate of *A* except that a small incomplete fistulous tract has been formed at the angle of the prostatic urethra by an unsuccessful attempt to catheterize the patient The "tooth paste" effect is obvious

D —Cysto-urethrogram of the same patient after attempts at catheterization had succeeded in breaking through the bar and completing the fistulous tract between the bladder and prostatic urethra The patient, 42, had had gonorrhea several years before, with occasional urethral discharge off and on for 10 years Cystoscopic examination showed a bridge of tissue across the internal urethral orifice This was cut away, and the prostatic urethra became large and funnel-shaped The patient was able to void better than he had for years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CARCINOMA OF THE PROSTATE Carcinoma typically produces diffuse infiltration of the gland which narrows the prostatic urethra so that both anteroposterior and lateral diameters are smaller than normal, though length is frequently increased. The normal curve is usually lost, so that the prostatic urethra may be straightened or show abnormal curves and irregularities. When the bladder is infiltrated, the filling defect is irregular and does not have the smooth contour of that produced by hyperplasia.

Carcinoma of the prostate may produce no radiographic changes in the prostatic urethra. With carcinoma and hyperplasia, deformities of both are likely to be present. Thus, one may see the smooth filling defect in the bladder from hyperplasia and the narrowed prostatic urethra from carcinoma. Chronic prostatitis may also produce changes in the prostatic urethra indistinguishable radiographically from carcinoma.

A.—Right oblique air cystogram showing irregular filling defect involving the bladder and extending along the wall—a characteristic of prostatic carcinoma when it infiltrates through the bladder wall. Autopsy confirmed invasion of the vesical neck. Pathologic diagnosis was adenocarcinoma.

B.—Right oblique cystogram demonstrating an irregular filling defect in the bladder. Transurethral resection was done. Pathologic diagnosis was adenocarcinoma and benign hyperplasia of the prostate.

C.—Right oblique cysto-urethrogram showing a straight prostatic urethra more narrow than normal, particularly at the vesical neck. The urethrogram is typical of carcinoma. The right pubis is dense and sclerotic—characteristic of metastases from prostatic carcinoma. Rectal examination showed a hard prostate which felt like carcinoma. Transurethral resection was done. Pathologic diagnosis was adenocarcinoma.

D.—Postoperative cysto-urethrogram showing the amount of tissue resected and adequate urethral lumen.

[Carcinoma of the prostate *continued on page 282*.]


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A—This cysto-urethrogram demonstrates a conical bladder with rough trabeculated wall but no filling defect The prostatic urethra is straight, narrow and irregular, an appearance typical of carcinoma Examination showed a hard, lobulated prostate Transurethral resection was done, and pathologic diagnosis was adenocarcinoma of the prostate

B—This oblique cysto-urethrogram shows a conical bladder The prostatic urethra is very narrow and straight Examination showed distention of the bladder to the umbilicus The prostate was moderately enlarged and firm and had the consistency of carcinoma Eleven grams of tissue was removed transurethrally Pathologic diagnosis was adenocarcinoma of the prostate

C—This oblique cysto-urethrogram shows a smooth bladder with no prostatic filling defect The lumen of the prostatic urethra is greatly narrowed The verumontanum cannot be seen, and there is a loss of the normal contour of the prostatic urethra which now is convex forward rather than backward The appearance is that of carcinoma of the prostate On rectal examination the prostate was hard and fixed Transurethral resection was done, and pathologic diagnosis was adenocarcinoma of the prostate

D—The prostatic urethra is straight, with a decrease in the size of the lumen and slight irregularity posteriorly The bladder is smooth and shows no prostatic filling defect In the absence of clinical signs and symptoms of prostatitis, a diagnosis of carcinoma of the prostate can be made without hesitation The prostate felt hard and irregular, but the patient was in too poor condition to offer him more than symptomatic treatment

[Carcinoma of the prostate *continued on page 284*]


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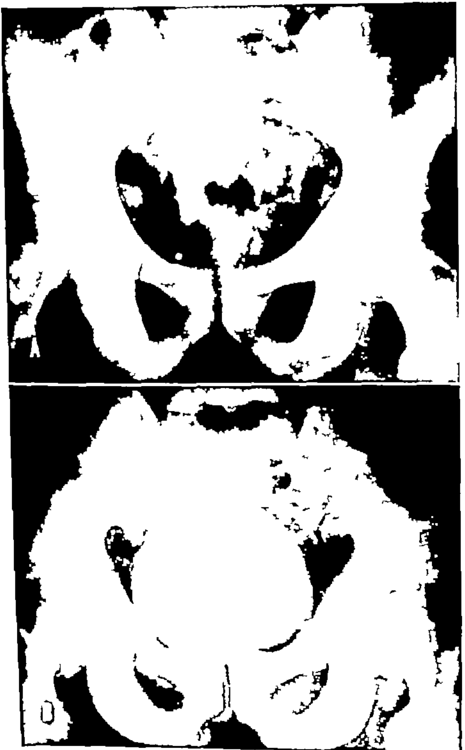
A.—Right oblique cysto-urethrogram showing the prostatic urethra narrow but smooth and no filling defect in the bladder. Verumontanum is not visualized. This is characteristic of carcinoma of the prostate. Transurethral resection was done. Pathologic diagnosis was adenocarcinoma and hyperplasia.

B.—Oblique cysto-urethrogram showing a smooth, rounded filling defect in the bladder. The prostatic urethra shows elongation, spreading and anterior tilting characteristic of benign hyperplasia of both lateral lobes and posterior commissure. There is nothing in the urethrogram to suggest carcinoma. This case demonstrates, however, that carcinoma of the prostate may be present without producing deformity of the urethra and may or may not accompany benign prostatic hyperplasia. Definite bony metastases in the pelvis were typical of carcinoma of the prostate. Rectal examination showed a large, hard, fixed prostate which felt like carcinoma. Stilbestrol improved urinary symptoms and relieved back pain.

C.—Oblique cysto-urethrogram demonstrating a small, smooth defect in the bladder suggesting benign prostatic hyperplasia. The prostatic urethra is elongated and narrowed at the vesical neck, suggesting carcinoma. The impression of the verumontanum is visible. The findings are minimal, and we believe an unqualified diagnosis should not be made. Rectal examination suggested carcinoma. Transurethral resection was done, and pathologic diagnosis was hyperplasia with carcinoma.

D.—Oblique cysto-urethrogram demonstrating a large, smooth filling defect in the bladder characteristic of benign hyperplasia. The prostatic urethra, however, is elongated and fails to show the spreading one would expect with a hyperplastic prostate. One must, therefore, suspect combined prostatic hyperplasia and carcinoma. Rectal examination showed a large, hard prostate which was not fixed but which definitely suggested carcinoma. Material was not obtained for microscopic examination.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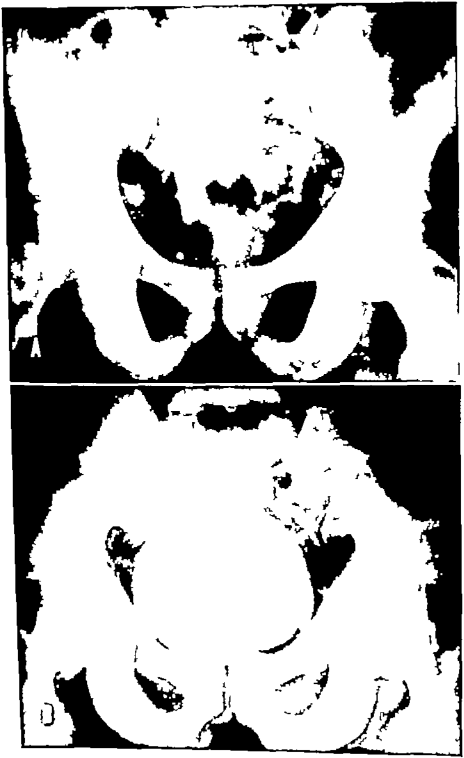
OSSEOUS METASTASES FROM CARCINOMA OF THE PROSTATE Carcinoma of the prostate frequently metastasizes to bone and, on the whole, the appearance of the secondary lesions is very characteristic Since the pelvis, lumbar vertebrae and upper portion of the femurs are most commonly involved, this should be kept in mind during the radiographic examination of any male patient within the cancer age

Typical metastatic lesions from carcinoma of the prostate stimulate bone reaction (osteoblastic metastasis), so that the area of the metastasis becomes dense and sclerotic Frequently, the involvement is extensive but not uniform, so that normal-appearing bone alternates with dense, sclerotic, circumscribed areas of invaded bone Occasionally but one bone, such as a vertebra, may be involved and appears white and ivory-like in comparison with the relatively uninvolved neighboring bone Metastases from carcinoma of the gastro-intestinal tract and thyroid rarely produce osteoblastic metastasis, carcinoma of the breast is the only other common neoplasm that may cause typical extensive osteoblastic metastases

A —This film of the pelvis shows typical extensive metastases from carcinoma of the prostate The density of normal bone does not approach that of this pelvis Close inspection shows that the increase in density is not uniform but occurs in multiple areas corresponding to the metastatic lesions The patient was given stilbestrol, with prompt relief of the pain A progress film in five months showed definite decrease in the density of the metastatic lesions

B —This opaque cystogram shows extensive and also typical metastatic lesions in the pelvis from carcinoma of the prostate Here the lesions are not as large or as dense as in *A*, but all visualized bones are involved

[Metastases from carcinoma of the prostate *continued on page 288*]



Osteoblastic metastases from carcinoma of the prostate are frequently seen as discrete areas of sclerosis, and when they occur singly it may be difficult or impossible without progress films to distinguish them radiographically from the so-called bone islands which are dense areas of sclerosis frequently found in bone. These do not change in appearance and are of no known clinical significance.

When discrete osteoblastic metastases are uniformly distributed throughout the pelvis, the appearance closely resembles osteopoikilosis, which is a hereditary form of multiple bone islands, also of no known clinical significance. When in doubt, the question can usually be settled by radiographic study of the wrists and ankles, since osteopoikilosis also involves these areas, whereas metastatic carcinoma rarely, if ever, does.

A.—Multiple discrete areas of osteoblastic metastases in the pelvis from carcinoma of the prostate. The patient, aged 69, had had increasing difficulty in urination for three years, culminating in complete retention. The prostate felt hard and firm. Transurethral resection was done, and pathologic diagnosis was adenocarcinoma of the prostate.

B.—Multiple discrete bone islands of osteopoikilosis, with typical distribution in the shoulders, wrists and ankles as well as in the pelvis. These were discovered incidentally during a gastrointestinal examination of the patient, a man of 22.

[Metastases from carcinoma of the prostate *continued on page 290.*]


B

Bony metastases from carcinoma of the prostate are usually multiple, although single lesions may occur. It is more common to find osteolytic and osteoblastic metastasis in the same bone, but occasionally entirely osteolytic lesions are encountered.

A.—The bodies of the ischium, ilium and pubis are dense and sclerotic from new bone formation due to metastasis from carcinoma of the prostate. The left half of the pelvis was comparatively uninvolved. Transurethral resection was done, and pathologic diagnosis was adenocarcinoma of the prostate.

B.—The destructive lesion of the ramus of the left pubis has the appearance of secondary neoplasm, but there is nothing to suggest the origin of the primary. Transurethral resection disclosed adenocarcinoma of the prostate.

OSTEITIS DEFORMANS. Bony production and absorption are also characteristic of osteitis deformans, or Paget's disease. Changes in the pelvis may be difficult to differentiate from metastasis from carcinoma of the prostate. In Paget's disease the trabeculae are coarse and dense, particularly those along the lines of greatest stress, as in the femoral head and neck. The bony cortex may become definitely thicker than normal. When in doubt, examination of the skull and long bones may show changes typical of Paget's disease, for these bones are seldom involved by metastasis from carcinoma of the prostate. Since Paget's disease and carcinoma of the prostate are common and both occur in the same age group, it is not unusual to find manifestations of both diseases in the same person.

C.—The pelvis of a man of 49 shows typical coarse trabeculae and areas of increased and decreased density characteristic of osteitis deformans.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THE NEUROGENIC BLADDER The neurogenic dysfunctions of the bladder are varied and complex Urologists have long recognized relaxation of the internal sphincter as being characteristic of "cord bladder" These changes are readily demonstrated radiographically and cystoscopically Opaque urethrograms demonstrate a definite widening of the prostatic urethra at the vesical neck In its mildest form, this consists of loss of the normal fusiform shape and assumption of a more cylindrical form However, the internal sphincter may become 2 or 3 cm wide, so that there is definite funneling of the vesical neck The impression of the external sphincter, however, remains distinct

A—Internal sphincter slightly but definitely relaxed in a man, 22, with acute myelogenous leukemia and numerous manifestations of nerve involvement, including incontinence of bowel and bladder

B—Relaxed internal sphincter in a man, 55, with neurosyphilis and impaired vesical sensation

C—Cylindrical widening of the prostatic urethra in its proximal half The impression of the external sphincter is distinct "Cord bladder" followed fracture of the spine

D—Great dilatation of the internal sphincter with an appearance suggesting a prostatic resection The impression of the external sphincter is well seen The patient, 55, was incontinent and had neurosyphilis

E—Complete relaxation of the internal sphincter with marked funneling of the vesical neck The impression of the external sphincter is not prominent The patient, 63, with tabes dorsalis, complained of urinary frequency and dribbling

F—Relaxation of the internal sphincter so that the proximal prostatic urethra is cylindrical The impression of the external sphincter is distinct Vertebral fracture 20 years previously in the patient, 66, was followed by urinary difficulty


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THE CAVERNOUS URETHRA The cavernous or anterior urethra is well demonstrated by urethrographic studies As measured on the film, it is about 2 cm in diameter and is definitely larger than described in the textbooks on anatomy and than one would expect from the size of the urinary stream During this type of examination it is, of course, distended to its greatest width The posterior portion is slightly wider and is limited proximally by the impression of the external sphincter

A —Normal cavernous urethra in a man of 63 with benign hyperplasia of the prostate

B —Normal cavernous urethra in a man of 71 with mild benign prostatic enlargement but no residual urine

Inflammatory Strictures —Inflammatory strictures of the cavernous urethra are characterized by the decrease in diameter and by the extensive involvement The lumen usually shows irregular narrowing for a considerable distance and is likely also to have localized areas of extreme narrowing, usually extending only a short distance Even following dilatation, the diagnosis of inflammatory stricture can readily be made because the urethra apparently never again distends to normal width, and although it may be of uniform diameter and have rather smooth walls, diffuse narrowing still remains

C —Urethrogram showing a cavernous urethra of uniform but decreased caliber, the appearance characteristic of an old stricture that has been dilated The patient, a man of 50, gave a history of gonorrhea 28 years previously, followed by a stricture which had been dilated many times

D —Typical appearance of an old inflammatory stricture that has been dilated The entire cavernous urethra is narrowed, although of uniform diameter The patient, a man of 74, had had gonorrhea 35 years before, followed by stricture He had had periodic dilatation of the stricture since then

[Strictures of cavernous urethra *continued on page 296*]


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A.—Anterior urethrogram showing several areas of narrowing in the posterior portion. One is filiform in size. The anterior portion also shows cylindrical narrowing typical of inflammatory stricture. The patient, aged 55, had had gonorrhea at 22 and chronic urethritis for years. For eight months he had had marked frequency and difficulty, with complete retention two weeks before. Attempts to pass a catheter had failed, and he had been able to void only with difficulty.

B.—Typical cylindrical narrowing of the distal portion of the cavernous urethra with a small segment of normal diameter near the membranous portion. The patient, aged 34, had had gonorrhea 12 years before, followed by stricture. This had been dilated sporadically, but not for the previous three years.

C.—Anterior urethrogram demonstrating complete stricture in the region of the membranous urethra. The proximal portion of the urethra *(1)* shows a double shadow due to extravasation into the corpus cavernosum *(2)*. This is an unusual picture because of the extravasation into the corpus cavernosum and the normal appearance of the anterior urethra, which is uncommon following inflammatory strictures. The patient, a man of 41, had had gonorrhea 27 years before. In the years following, the stricture had been dilated many times. Six days before admission complete retention developed. Several attempts to pass the stricture had failed.

D.—Urethogram demonstrating complete stricture of the proximal portion of the cavernous urethra. No opaque material has passed into the bladder which, however, is outlined by air from a suprapubic cystotomy. The urethra *(1)* is of nearly normal diameter, but there is extravasation not only into the corpus cavernosum *(2)* but into the surrounding veins. On catheterization, a filiform stricture of the anterior urethra was found. Etiology of the stricture was not determined.


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PERINEAL FISTULAS These are commonly found in association with and as the result of gonorrheal strictures, but they may result from trauma, such as instrumentation or penetrating wounds

A—Perineal fistula with visualization of the proximal portion of the cavernous urethra The patient had had gonorrhea followed by stricture when a young man He had been having increasing difficulty for 12 years and had developed a periurethral abscess that had been drained through the perineum This had resulted in a fistula

B—Perineal fistula in a man of 73 who had had a transurethral resection of the prostate elsewhere three years before Recently a tender mass had developed in the perineum This had been drained and was followed by the fistula There was no history of gonorrhea, and we believe the stricture and abscess developed as a result of the trauma incident to the transurethral resection

CARCINOMA *C*—Urethrogram showing a cylindrical stricture of the anterior urethra with a perineal fistula There is no radiographic evidence of the carcinoma which was present The patient, a man of 53, had had gonorrhea 30 years before, followed by stricture and perineal fistula He had had many fistulas since Four months before, a mass had developed in the perineum This was excised Pathologic diagnosis was undifferentiated carcinoma

METASTATIC CARCINOMA *D*—"Napkin ring" narrowing of the anterior urethra in a man of 60 whose rectum had been removed three years previously for carcinoma For the past three months there had been increased difficulty on urination Amputation of the penis was done Pathologic diagnosis was metastasis of adenocarcinoma of rectum to the urethra


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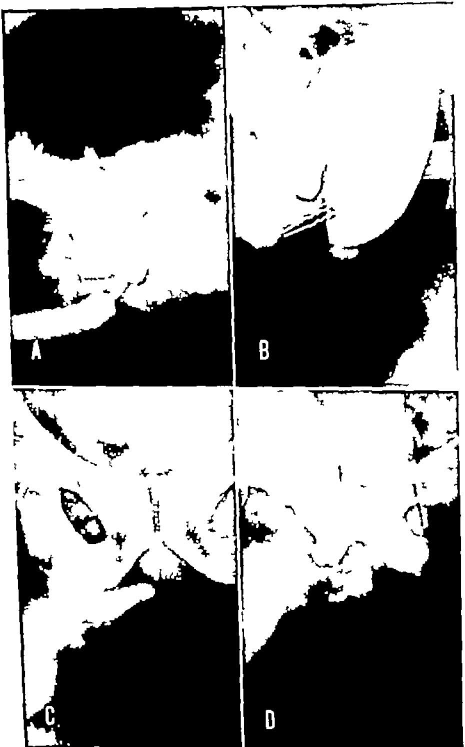
PERINEAL FISTULAS These are commonly found in association with and as the result of gonorrheal strictures, but they may result from trauma, such as instrumentation or penetrating wounds.

A.—Perineal fistula with visualization of the proximal portion of the cavernous urethra. The patient had had gonorrhea followed by stricture when a young man. He had been having increasing difficulty for 12 years and had developed a periurethral abscess that had been drained through the perineum. This had resulted in a fistula.

B.—Perineal fistula in a man of 73 who had had a transurethral resection of the prostate elsewhere three years before. Recently a tender mass had developed in the perineum. This had been drained and was followed by the fistula. There was no history of gonorrhea, and we believe the stricture and abscess developed as a result of the trauma incident to the transurethral resection.

CARCINOMA *C*.—Urethrogram showing a cylindrical stricture of the anterior urethra with a perineal fistula. There is no radiographic evidence of the carcinoma which was present. The patient, a man of 53, had had gonorrhea 30 years before, followed by stricture and perineal fistula. He had had many fistulas since. Four months before, a mass had developed in the perineum. This was excised. Pathologic diagnosis was undifferentiated carcinoma.

METASTATIC CARCINOMA *D*.—"Napkin ring" narrowing of the anterior urethra in a man of 60 whose rectum had been removed three years previously for carcinoma. For the past three months there had been increased difficulty on urination. Amputation of the penis was done. Pathologic diagnosis was metastasis of adenocarcinoma of rectum to the urethra.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TRAUMATIC STRICTURE In contradistinction to inflammatory strictures, traumatic strictures are localized

A —A cysto-urethrogram shows a typical traumatic stricture localized to a segment of the cavernous urethra, the anterior and posterior portions are normal The patient fell seven months before, receiving a straddle injury This was followed by pain, bleeding and difficulty in voiding which increased in severity until he was only able to dribble The stricture could be dilated but closed rapidly in a few days, necessitating weekly treatments

FOREIGN BODIES These are as varied as the objects that can be placed in the urethra

B —The patient, a man of 23, had spastic paraplegia and low mentality He inserted a hairpin in the urethra three days prior to admission This could be palpated in the bulbous urethra and was removed by forceps

STONES Urethral stones are rare They may develop in the urethra or in a urethral diverticulum Usually, however, they are passed from the bladder and lodge in the urethra The symptoms are then immediate and urgent

C —A bullet-shaped calculus is located in the posterior portion of the cavernous urethra The present difficulty had begun 24 hours before, while urinating, he had severe pain in the penis and perineum and the urinary stream suddenly stopped Attempts to pass a catheter were unsuccessful, and a urethrolithotomy was therefore done

D —A film of the urethra without contrast medium shows the posterior portion of the cavernous urethra and the prostatic urethra outlined by innumerable small calculi An inflammatory stricture is obvious The patient had had gonorrhea nine years before, followed by stricture and multiple perineal fistulas A urethrotomy was done, and "innumerable" small stones were removed


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PERIURETHRAL DIVERTICULA AND ABSCESSES

Diverticula of the cavernous urethra are readily demonstrated by urethrographic studies Whether they are congenital or acquired cannot be determined from the radiograph In fact, it is impossible to differentiate a diverticulum from an abscess cavity by the radiographic appearance Both are readily demonstrated when they communicate with the urethra When visualized, they show as rounded collections of opaque material, usually located below the urethra The most frequent site is the posterior portion of the cavernous urethra, and many are undoubtedly the result of trauma during instrumentation

A —This oblique cysto-urethrogram shows cylindrical narrowing of the anterior urethra characteristic of a stricture The posterior portion of the urethra is not involved There is also a large extra-urethral collection of opaque material and air The patient, a man of 80, had a history of dribbling for 1½ year He had been catheterizing himself occasionally for two or three months He was shown how to express the urine from the cavity, and since there was little evidence of obstruction of the vesical neck, nothing further was done

B —A small pocket is located inferior to the posterior portion of the bulbous urethra The remaining portion of the cavernous urethra is entirely normal The small diverticulum was an incidental finding

C —An anterior urethrogram demonstrates a large pocket of opaque material inferior to the midportion of the urethra The anterior urethra appears cylindrical and narrowed, suggesting stricture The patient, a man of 79, was admitted because of incontinence and a cystic mass connected with the urethra This filled with urine, which could be expressed Both complaints had been present since a suprapubic prostatectomy done elsewhere two years before

D —This cysto-urethrogram demonstrates cylindrical narrowing of the anterior urethra, indicating a stricture, and a collection of opaque material below the bulbous urethra The patient, a man of 78, had had incomplete retention and had noticed a swelling in the perineal region for two weeks He had been catheterizing himself for the past three years with increasing


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difficulty Two weeks before, he had noted some swelling and tenderness in the perineum Examination showed swelling, in duration and increased temperature of the scrotum and perineum Thick pus could be expressed from the penile meatus The prostate was mildly enlarged, smooth and firm The periurethral abscess was drained through the perineum and foul pus obtained Indwelling catheter drainage was then established A suprapubic prostatectomy was done later When discharged, the patient was urinating well and had no residual urine

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